

AL-BIRUNI

His Times, Life and Works

Hafiz Sadi

Dr. A. Zahid



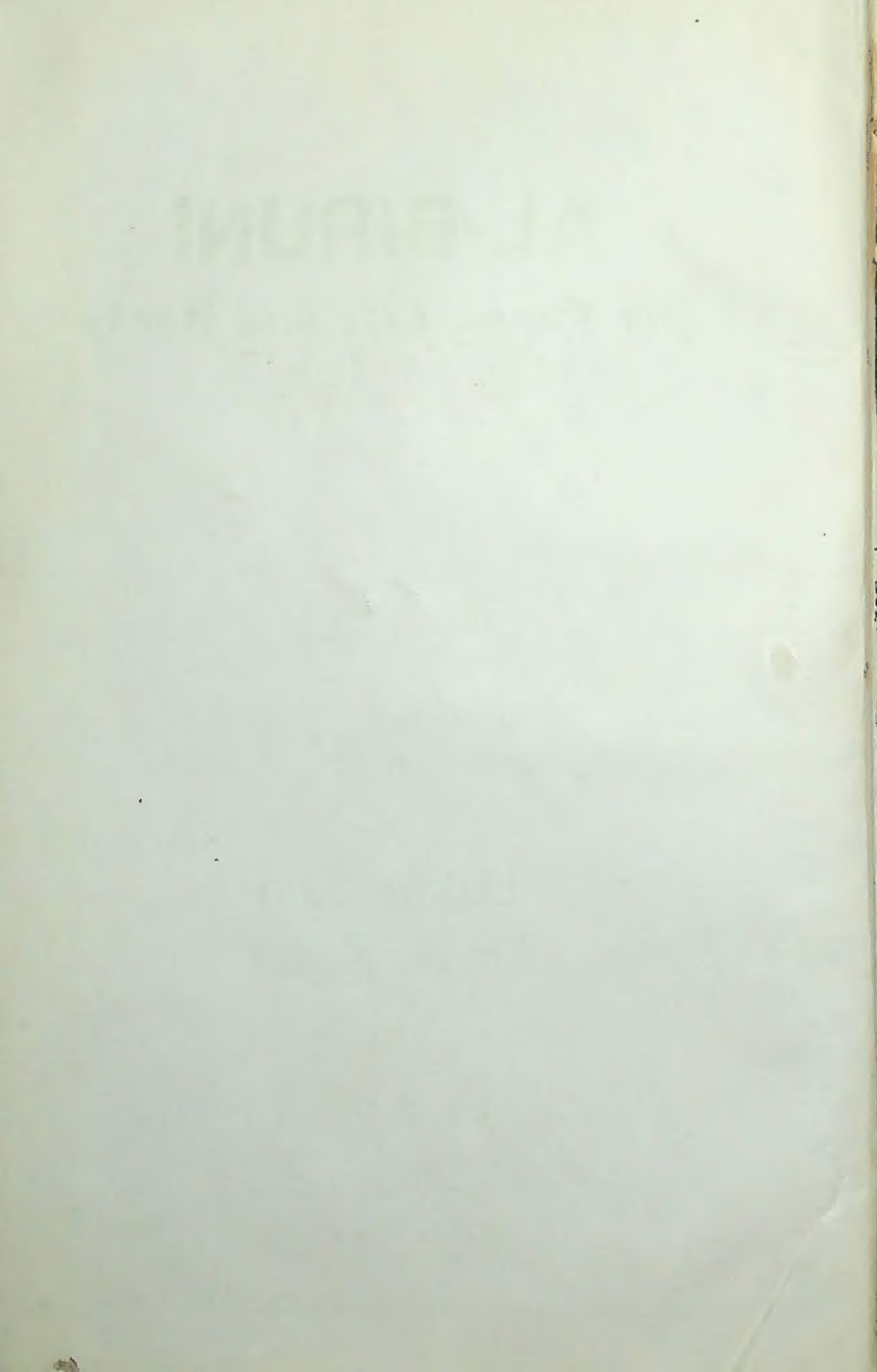
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FOREWORD

I am happy at being asked to write a foreword to one of the very important and useful books published in Pakistan on an aspect of the remarkable contribution made by Muslims to scientific studies and research in the medieval centuries. *AL-BĪRŪNĪ – His Times, Life and Works* by Hakim Mohammed Said and his co-author, Dr. Ansar Zahid Khan, based on the joint researches of an eminent scientist of international fame and a well-known Pakistani scholar of history will be read with interest and advantage by all those who are interested in the study of Islamic contribution to the growth and expansion of knowledge.

An idea of Abū Rayḥān al-Bīrūnī's position as a scientist and scholar can be formed from the fact that the eleventh century has been regarded as the "Age of al-Bīrūnī". Born and trained at Khwārizm, he rose to be a versatile scholar of the highest order, a great scientist, mathematician, astronomer and historian. Such a diversified manifestation of genius is, indeed, a unique feature of medieval scholarship. Unfortunately, however, his achievement in the various branches of learning has escaped general attention and recognition, although it was known to scholars and historians. Perhaps this neglect was due to the multi-dimensional nature of al-Bīrūnī's personality. Only a scientist with historical training or vice-versa could rightly appreciate his researches.

Hakim Mohammed Said, President of the Hamdard Foundation Pakistan, who has been serving the cause of learning and research through his organization for years, has successfully focussed the attention of scholars on the work of al-Bīrūnī by celebrating al-Bīrūnī's millenary in 1973. He rightly decided to produce a

comprehensive biography, associating with himself Dr. Ansar Zahid Khan, Hony. Joint Secretary of the Pakistan Historical Society, and a hardworking research scholar of medieval and modern history of South Asia.

The book comprises seven chapters. The first chapter, "Age of al-Bīrūnī", contains an account of the impact of Islam on the spread of education and learning, providing a study of its unifying and invigorating role. It is interesting to know how the Turks were drawn into the vortex of Islamic society and became in the process of transformation one of the most remarkable human groups in history. This made Khurasan and Transoxiana great centres of learning producing eminent scholars like Muḥammad Ibn Mūsā al-Khwārizmī (d. 850 A.D.) Abū Naṣr Fārābī (d. 950/952) and al-Bīrūnī. The chapter provides a good historical perspective.

Chapters II and III discuss the life of Al-Bīrūnī at Khwārizm and Ghaznin. From the point of research and historical information they are very important. In a discussion of the origin of Bīrūnī it is suggested that it may be traced to the word *Bīrūn* meaning an outsider or non-local. After a discussion of the nomenclature and family of Bīrūnī the authors give an account of his education, teachers and linguistic skill. The emphasis is on his "insatiable thirst for knowledge" and total devotion to learning till his last breath. After wandering from Kāth to Rayy etc., he finally reached Khwārizm where outstanding scholars, including Ibn Sīnā, were present. During the reign of Abū al-'Abbās Sultan Maḥmūd's attack and conquest of Khwārizm has become the centre of a controversy. The authors have discussed all aspects of this controversy examining various myths and accusations levelled against Maḥmūd. One may say that in fact two myths have been compounded into one giving a very distorted image of the great ruler. One is the story of *Chahār Maqālah* suggesting that Maḥmūd attacked Khwārizm because when he demanded from the ruler of the kingdom the surrender of the great scholars, Ibn-Sīnā, Khummār and al-Bīrūnī, he refused hence Sachau branded him as a "kidnapper of scholars". The story is carried further and it is said that Maḥmūd kept al-Bīrūnī as a captive in India.

The authors deal with the problem scientifically. They examine

the story of Maḥmūd's attack on Khwārizm and trace it to the fact that Abū al-'Abbās, although Maḥmūd's brother-in-law, displeased him by flirting with the Turkish chiefs of Central Asia. The whole question was related to the issue of paramountacy. But the attack came after the rebellious soldiers and chiefs had killed Abū al-'Abbās. The myth is further demolished by proving that Ibn Sīnā had left Khwārizm in 1012-13 that is five years before Maḥmūd's conquest (1017). The other portion of the story is also treated in the same manner. Sachau's contention that al-Bīrūnī was angry with Maḥmūd has been successfully disposed off and it has been pointed out that the *Chahār Maqālah* and *Nigāristān* are not contemporary works and episodes mentioned therein should not be taken on their face value. The authors have put forward al-Bīrūnī's *qasidah* on Abū al-Faṭḥ Bustī. The verses relating to Maḥmūd are very interesting:

ولم ينقبض محمود عنى بنعمه فاغنى واقنتى مغنيا عن مكاسيا
(Maḥmūd did not grudge me any good things of life, he made me rich and by-passed my harsh demands).

عفا عن جهالاتى وابدى تكرما وطرى بجاه رونقى ولباسيا
(He pardoned my ignorance and began to appreciate me and his appreciation refreshed my looks and dress).

Even in *al-Hind* he referred to him respectfully invoking God's mercy on him. (Vol. I, pp. 223, 116; II, pp. 213, 103). He referred to him as "the strongest of the pillars (of Islam), the pattern of sultan Maḥmūd, the lion of the world and the rarity of the age, may God's mercy with him" (*India*, Vol. II, p. 2). The same is true of the *Qānūn al-Mas'ūdī*.

By examining references and dates about the presence of al-Bīrūnī in Kabul, Ghaznin and outside India the authors challenge the plausibility of his continued forced sojourn in the Panjab. They have arrived at the conclusion that only three possible periods of his presence in India emerge viz. 1020-21, 1023-24 and 1028-29. These could have been the periods of his visit to India. However, there is one problem that the period of his stay appears short for a foreigner to learn Sanskrit so well. But keeping in mind al-Bīrūnī's

immense capacity of hard labour, concentration and will-power the difficulties were surmounted or as the authors suggest he could have become familiar with that language at Kabul. The discussion about Mahmūd's bilingual coins and possibility of al-Bīrūnī's involvement is interesting. The chapter ends with his relations with Mas'ūd and Mawdūd, followed by an account of his death.

The next chapter (IV) is devoted to al-Bīrūnī's contemporaries; his controversial involvement with Ibn Sīnā is an interesting study.

The next three chapters are important as they contain a discussion of al-Bīrūnī's achievements as an astronomer, scientist and scholar of human sciences and society, including history. As an astronomer al-Bīrūnī despised astrological interpretations but at the same time condemned those fanatics who branded it as heresy. To him it was just a scientific discipline, a study of the movements of heavenly bodies. Here also some of his researches were better and find confirmation in modern scientific researches. The chapter is full of scientific and technical discussions. The authors have presented a clear and comprehensive treatment of a difficult subject.

The same is true of his status as a scientist. The chapter is divided into sections discussing his contribution to mathematics, spherical trigonometry and Indian arithmetic. It is interesting to note that in spite of his skill and command on these disciplines he did not discuss music or musical notations. The other topics are light and sound, gravity, density, mechanics, weights and measures, chemistry and alchemy. A notable work was his *al-Saydanah*, a pharmacopoeia-cum-materia medica of medicines. He also dealt with geography, geodesy, startography and botany. In this respect the great master presents a fresh, clearer and better informed vision of the earth, the oceans, the land, distances involved, etc. However, his main contribution was the description of India. The authors devote enough space to this important discussion, his measurement of the circumference of earth at Nandana, his contribution to the study of stars, longitudes, latitudes based on the readings of 600 towns with Ghaznin as the focal point. This gigantic labour and effort has given him the status of the father of geodesy.

The last chapter deals with human sciences including history.

The authors have succeeded in bringing out Muslim conception of history as an attempt to get at the truth by a subtle explanation of the causes and origins of existing things and deep knowledge of the causes and effects of the events.

They point out the fact that al-Bīrūnī differed from others in presenting history of people, their beliefs and customs as well. He excelled in chronological computation of years and dates. But at the same time he had a clear concept of the ideal of a historian. His correct view and reasoning leads him to think that the institution of *varana* (caste) based on inequality was the main obstacle in a rapport between Hindus and Muslims. The condition of Indian learning, languages, script, centres of learning is also brought out.

The book is properly documented, well illustrated and quite readable, and I have not the least doubt that it will prove to be a valuable addition to material available in modern languages for the study of eminent Muslim scholars and their achievement. Historians and other research scholars will be immensely benefited by its study.

DR. S. MOINUL HAQ

General Secretary & Director of Research
Pakistan Historical Society, Karachi



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CHAPTER I

AGE OF AL-BĪRŪNĪ

UNITY IN DIVERSITY

Abū Rayḥān al-Bīrūnī is one of those rare prodigious minds at work in the medieval world — a creative, versatile and outstanding scientist whose international outlook and universality of thought and feeling still amazes the modern world. He is a synthetiser more than a dogmatic scholar, an alert observer who is all the time ready to broaden his horizon of learning and a student of comparative studies *par excellence*.¹ A correct appraisal of so eminent a man would require a careful study of the various circumstances and forces responsible for the flowering of his genius.

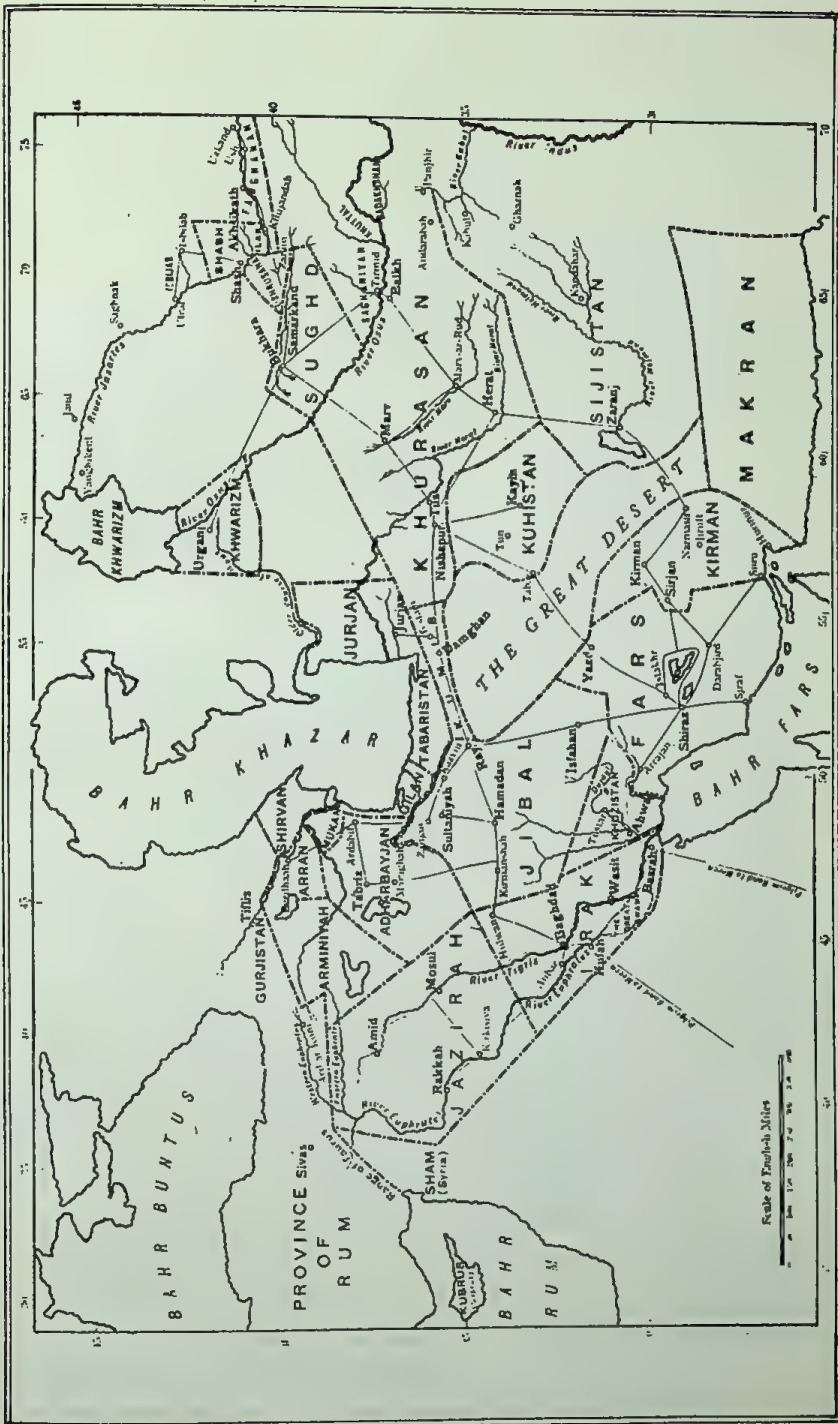
The events of history, not only of the north-western flank of the Indo-Pakistan sub-continent but also of west Asia would have been different had it not been for Qutaybah bin Muslim, who captured Samarqand in 711 A.D., and in the process also Khwārizm (Khiva), during the reign of the Umayyid Caliph Walīd bin ‘Abd al-Malik. Thence the Islamic influence spread southward and eastward, bringing within its fold Afghanistan and the north-western region of the Indo-Pakistan sub-continent. It was from this conquest — and through the accumulation of other stimulants — that the Turanian genius asserted itself. Not only Abū ‘Abd Allāh Muḥammad ibn Mūsā al-Khwārizmī (d. 850 A.D.), al-Bīrūnī, and Abū Naṣr Fārābī (d. 950 or 952 A.D.), Jalāl al-Dīn Rūmī the poet, but also several outstanding generals and conquerors who came forth from Turkistan going as far west as Turkey and Egypt (the Ottoman Turks and the Mamluks) and eastward through Afghanistan down

to the Deccan in the Indo-Pakistan sub-continent. Perhaps the Khurasanian garrisons under Qutaybah could have achieved much more had not Walīd's vindictive brother Sulaymān put a stop to this outburst of energy and restrained Mūsā bin Nuṣayr, Qutaybah and Muhammad bin Qasim, the conqueror of Makran and Sind. Al-Bīrūnī was born 262 years after the conquest of his native land by the great Qutaybah.

Al-Bīrūnī saw the light of the day in the region of Khwārizm at the north-eastern periphery of the Islamic world. The socio-economic, political and cultural life of this region, towards the close of the first millennium of the Christian era, was a product of the various historical forces, actions, reactions, and 'racial and cultural drifts', the last of which was represented by the 'Abbasid Caliphate. The Umayyid, the original conquerors of Khwārizm, had since been supplanted.

A cursory glance over the past centuries of the region comprising the Islamic Caliphate reveals certain distinct patterns of evolution. It has been suggested that the Caliphate was in fact the restoration of the old Syriac and Achaeminian empires.² These empires, trying to stem the impact of Hellenism with the help of Judaism and Christianity, finally accepted the triumph of the rising form of Islam.³ The Islamic Caliphate not only restored the old 'universal state' of the Achaeminian epoch,⁴ but it also united the two hostile regions into one, thus extending for the first time the expanse of this latest 'middle eastern' empire right up to the shores of Atlantic. Most of the regions of the ancient Hellenistic world in the west as well as in the east were again united.⁵ It would therefore not be incorrect to say that the Caliphate restored the cultural unity of the Hellenistic age and was considered a successor to both the ancient Syriac and Achaeminian society and the Hellenistic heritage. Rather, it achieved a synthesis of the two cultures with the new socio-economic basis of equality, justice and fraternity. This synthesis is borne out by the cultural and literary activity of the Muslim society in the heyday of the Caliphate and even during the period of 'tawā'if al-mulūkī' (rule by petty dynasties).

The heartland (*qalb*) of the Caliphate (i.e., Syria and Iraq, two of the most fertile areas of the world and ancient cradles of



Map showing Khwarizm and neighbouring region

civilization)⁶ is flanked by two comparatively less fertile zones, viz., the Arabian desert in the south-east and the Central Asian Steppes in the north. Though generally 'prisoner of climate and geography', the nomads of these regions, either drawn in by the degeneration of the civilization of the *qalb* or propelled forward by some external thrust, were responsible for a number of *volkerwanderungs* from the early Semitic occupation of Iraq, down to the Arabs, the Turks, and the Mongols of the Middle Ages. Among these 'racial drifts' the *volkerwanderung* of the Arabs during the 7th century A.D. and the Turks in the 9th and the 10th centuries A.D. were different in nature from the devastating invasions of the wild nomads of the earlier periods or that of the Mongols subsequently. The hostile nomadic incursions were carried out by those variegated groups of people who were inured to a way of life diametrically opposed to a settled life and, viewing the external manifestations of the urban culture as nothing short of the useless frills of existence, tried to do away with them⁷ as they would have done away with redundant goods in their nomadic life. The Arabs and the Turks on the other hand, were not totally ignorant of city life. In fact, the economic life of the Arabian Bedouin centred around cities e.g., Mecca, a spiritual sanctuary as well as a commercial centre of the region⁸ and Yathrib (Medina).

The Arab *volkerwanderung* leading to the establishment of the Caliphate, was preceded by maritime wanderings of the Arab merchants and sailors whose seafaring activities reached right up to the confines of Indonesia and China.

This maritime and overland expansion of the Arabs has baffled the historians.⁹ Some orientalists, basing their arguments on mere conjectural hypothesis rather than facts, have propounded the theory of the pressure of population.¹⁰ The pressure of population could have been a reason but there is no evidence to support it, or to show the existence of any economic crisis for precipitating and generating the political, religio-cultural and economic expansion of the Muslim Arabs. Their wandering was, in fact, the dynamised expression of the nascent Arab national ethos which, combining with the cosmopolitan outlook of the Arab city-dwellers, gave birth to an international revolution in the 7th century A.D. This revolution, like other great revolutions that have stirred mankind from sloth and

slumber and enabled nations to lead the vanguard of human progress, was based on the ideals of equality, fraternity and justice. The Arabs, fired by this new message and stimulated into action by the careless wardens of the marches of Iran and the Byzantium, surged forward. The economic gains attending this expansion were also responsible for sustaining this outward movement. This astonishing career of the conquests owed itself not only to the missionary zeal of the early converts and the weakened state of the neighbouring empires,¹¹ but also to a great extent, to their new message and their character. The former, by opening new vistas of liberty and equality for the down-trodden masses, won their sympathy,¹² while the integrity, intrepidity and piety overwhelmed the morally debased cultures and melted away all resistance.¹³ Thus the impact of Islam struck deep roots. A better appreciation of this influence of Islam over the conquered regions *vis-a-vis* Hellenism has led modern orientalist to revise their thinking and to admit that despite its shorter span than that of Hellenism, Islam's impact was far deeper and more permanent than its predecessor's.¹⁴

These regions of the Middle East had been subjected to different major racial and cultural drifts, viz., the Aryan, the Hellenistic, the Semitic and the Islamic, which served as 'challenge and response' or action and reaction for each other.

However, it seems that notwithstanding the universal character of Islam, its political manifestation in the form of the Caliphate remained a sort of super-imposition of a common veneer which did not cause the various groups and regions to lose their peculiar and particular shade. For this the Umayyids and the 'Abbāsids were themselves in great part responsible. It was a unity with diversity.¹⁵ Conflict between the 'bigger', the universal tradition and the 'smaller' or lower tradition of the regions appears to have characterised the Muslim society from the early days of the Caliphate.¹⁶

Repeated interactions between these two forces, centripetal and centrifugal in nature, initiated periods of conflicts and integrations. In the first conflict the Muslim Arabs, having achieved their political unity and socio-economic regeneration, overwhelmed the Byzantine and Iranian empires and imposed the Arabic language and culture. The existing imperial administrations were adapted. However, the

Arabs failed to maintain an equilibrium between the revolutionary concept of equality and their own parochial political ambitions. Three major ethnological groups (the Arabs, the Iranians and the Berbers) comprised the bulk of the population of the Caliphate. The resentment of the non-Arab Muslims and non-Muslims to the racial discrimination practised by the Arabs by monopolising all economic gains for themselves, against the injunctions of the *Qur'ān* and the Prophet (peace be on him), gave rise to demands for equality. These tendencies have been designated as *Shā'ūbite* tendencies.¹⁷ The failure of the Arabs to meet the challenge of the *Shā'ūbite* tendencies according to the principles of Islam precipitated a crisis. The Arabs' parochial attitude eventually led to intense sectarian and tribal conflicts among themselves as well and, in this way, the Arab hegemony was weakened thereby allowing the Khurasanis (the Persians) and subsequently the Berbers to gain ascendancy in the form of the 'Abbāsīd and the Fātimīd Caliphates.

It may be said that the vast area of the Caliphate including several socio-economic and cultural units could not have remained long under centralised control. The process of break up may be said to have started with the rise of the 'Abbāsīds, which created the first breach in the monolithic Arab Caliphate.

The Umayyīd dynasty, by its very nature a military autocracy, established itself firmly and entered into an unprecedented course of conquest. This created great frustration among the hostile forces who started conspiracy against the Umayyīds. All these different tendencies and drifting elements, gradually coalesced into an anti-Umayyīd movement, spearheaded by the 'Abbasīds.

As the conflict between the 'big tradition' and the 'small tradition' grew, it gave birth to diverse reactions. In some instances a synthesis and integration of the two traditions was noted such as the Sufistic doctrines of Ibn al-'Arabi (d. 952 A.D.). Owing to cultural divergence this conflict also crystallized into sectarian developments. This was particularly true of the regions which were situated at the periphery of the Caliphate and were less permeated by the 'big tradition'. Thus the *Khārījī* and the *Ismā'īlī* doctrines found favour with the Berbers of North Africa and the 'Abbāsīd movements became popular in Iran and Khurasan. However, Hijaz still adhered

to the memories of the Pious Caliphate and to its days of glory. Syria could not forget its past grandeur under the Umayyids. Kufah and Basrah continued to be centres of the supporters of Zubayr and Talhah.

Though little is known about the factors which persuaded the 'Abbāsids to choose Iran and Khurasan for their propaganda, it seems that repeated failures of anti-Umayyid movements in *qalb* of the Caliphate i.e., the Arab regions, persuaded the opponents of the Umayyids to seek a more congenial ground. The Persians still prided themselves upon their past glory and regarded themselves culturally superior to the Arabs.¹⁸ They were not happy with the Umayyid rulers. The 'Abbāsids, more pragmatic and materialistic than the 'Alids, seized control of the anti-Umayyid movement and used every method to attract a following. Thus, while during the Umayyid days, the hegemony of the Arabs went unquestioned, during the 'Abbāsīd days the non-Arabs gained dominance, although superficially the rule appeared to be of the Arabs.

But the support extended to the 'Abbāsids by the non-Arabs was one of the factors of their success. Another important element was the persuasive power of the 'Abbāsīd *imāms*. They convinced the Muslims, Arabs and non-Arabs, that they would rule according to the *Qur'ān* and *Sunnah*. Tyranny and inequality would be banished. In *Rabī' al-Thānī* 132H./750 A.D., while receiving the allegiance of the people of Kufah, he recounted the evils of the Umayyids and said: 'It is my hope that from the family which brought you good advice, you will not get harsh treatment and deceit.' Similarly Dā'ūd b. 'Alī, the cousin of Saffah, also addressed the gathering as follows: "We have not come out of our homes to garner silver and gold or to build palaces, or to have canals and aqueducts dug there but to regain our rightful share. The progeny of Abī Tālib has been subjected to one wrong doing after another, and the Umayyids were treading the wrong path. They interfered with the *bayt al-māl*. It now devolves upon us — through our responsibility to God, His Prophet, and 'Abbās — that we would govern according to the examples left to us by the Holy Prophet."¹⁹ The extent to which the 'Abbāsids used the anti-Arab sentiment prevalent in Iran, may be seen from the letter purporting to be an epistle of the 'Abbāsīd

Imām Ibrāhīm asking his Khurasani *dā'ī* to weed out all the Arabic words from the Persian.²⁰

Out of all the regions of Iran, Khurasan together with the neighbouring Transoxiana, situated at the frontier of the Caliphate, with their fertility and also possessing the hilly terrain of Jabal-i-Khurasan,²¹ were best suited to support and nurture movements against the Caliphate. On the other hand, southern Iran or Fars proper was arid and hilly and the regions in the west were far too close to Iraq and Syria to support anti-Arab movements. Besides this the pre-Islamic creeds such as the Majūsis, the Zindīqis (the Manichaeans) and Muzdakis (also called *Khurramis* after the wife of Muzdak) driven out by Islam, had retreated to the hilly fortress of the Jabal-i-Khurasan. Proximity to Zāblustān (Afghanistan) and Turkistan (Transoxiana) made Khurasan an ideal place for subversive activities because the saboteurs could easily avoid capture and find shelter in the adjoining areas among people with like-minded mental attitudes.²²

The 'Abbāsīd *dā'īs* either with the connivance of their *imāms* but more probably in their own enthusiasm, made full use of the non-Muslim beliefs. The manner in which the Rāwandīs regarded the 'Abbāsīd *imāms* and Caliph as God²³ and the way Abū Muslim was sanctified and deified even by the non-Muslims of Khurasan suggest that the ideas of *tanāsukh* (metempsychosis), *hulūl* (incarnation), *ghulū* (deification) and *taqṣīr* (lowering God's status to that of a man) were unscrupulously used.²⁴

The success of the 'Abbāsīds enabled the Persians or Khurasanians to play an increasingly important role in the Caliphate.²⁵ Their power reached its apogee in the reigns of Hārūn and Ma'mūn. Twice the Khurasanians played the role of Caliph-makers; first when they toppled the Umayyids and secondly when they helped al-Ma'mūn, the son of a Persian slave girl, to defeat Amīn, the candidate of the Arab party.

The rising power of the Khurasanians, their desire for freedom created by repeated revolts, as well as that of the Jabal, its prosperity together with its long distance from the *qalb* of the Caliphate made Khurasan the first region to shake off Arab rule. The Tāhirids or the Persianised Arab dynasty, were thus able to achieve semi-

independence. It marked the first stage in Khurasan's journey towards full independence.

Though the process of disintegration had become manifest during the reigns of Hārūn and Ma'mūn, when the Tāhirids in Khurasan and the Aghlabids of Maghrib (Morocco and Algiers) became semi-independent, for some time nevertheless the Caliphate lived on the borrowed strength of the Turkish or Circassian mercenaries. However, the infusion of these 'barbarian tribes', in fact, accelerated the process of disintegration. The Circassians, in fact, became like the Praetorian guards of the Roman empire of the latter day, purveying their loyalty to the highest bidder. These doughty warriors soon became aware of their own strength, and the weakness of the Caliphate. The conflict between the ambitious Turkish chiefs and the Caliphs finally resulted in the assassination of al-Mutawakkil (d. 847 A.D.) which marked the end of the glorious century of the 'Abbāsids. An era of weak Caliphs controlled by families of powerful chiefs, Turkish, or Buwayhids, was ushered in. A number of independent local dynasties emerged generally paying only nominal allegiance to the Caliphs.²⁶

Ya'qūb b. Layth al-Saffār (coppersmith), an opportunist of humble and indigenous origin in Sijistān (Sīstān or Nīmruz) by a freak of fortune was entrusted with a post of trust at the court of the Caliph's governor of Sijistān. Ya'qūb eventually succeeded to the governorship and within a short time established control over Herat, Fars, Balkh, Tukhāristān and in 872 A.D. destroyed the Tāhirid power and occupied Khurasan. Soon his ambition led him to attempt to capture Baghdad. This proved abortive. On his return he died and was succeeded by his brother 'Āmir Saffār (903 A.D.). The Caliph, al-Mu'tamid, having failed to reach an understanding with the Saffārids, allied himself with the rising power of the Sāmānids of Transoxiana who defeated 'Āmir. Hereafter the Saffārids continued to enjoy for a short spell a chequered and precarious existence in Sijistān before sinking into oblivion.²⁷

Sāmān, the ancestor of Sāmānids was a Persian noble of Balkh, a Majūsī converted to Islam, in the reign of al-Ma'mūn. Out of them Nūh was awarded Samarqand, Ahmad received Farghana, Yahyā got Shash, while Ilyās was given Herat. Ahmad succeeded his brother

at Samarqand, acquired power and seized Kashghar. Ahmad's son, Ismā'īl, defeated the Saffarids, conquered Khurasan and also snatched Tabaristān from the 'Alids. The whole of Persia and Khurasan thus came under his sway. Under his rule Samarqand and Bukhara grew in importance and became centres of commerce, political power and learning. However, after his death, decay set in. Rebellions and the rising power of the Buwayhids, stripped them of the Persian provinces. At the same time the Īlak Khān of Turkistan threatened Transoxiana. The Sāmānid ruler's increasing reliance on the Turkish slaves proved his own undoing. Alaptgīn, one such slave chief, became too powerful. Driven from the Sāmānid dominions he established himself at Ghaznah where subsequently his slave and successor Subuktgīn established a new dynasty. In this way by the last quarter of the 10th century the Sāmānids beset from all sides rapidly lost power. Finally, the Īlak Khāns delivered the *coup de grace* in 995 A.D., and occupied Bukhara.²⁸

The Buwayhids claimed descent from the ancient kings of Persia. Buwayh, the chief of the warlike highland clan of Daylam, left the service of the Sāmānids, and went over to the Ziyārīds. His sons rapidly increased in power and occupied Gilan, Isfahan, Kāzīrūn and Shiraz. One of them, Mu'iz al-Dawlah, reducing Kirman and Ahwaz, entered Baghdad. He became *amir al-umārā*. Though basically Shī'ite, they kept the Sunni Caliph in power, for an 'Alid Caliph commanding respect from the Shī'ah soldiery of Daylam could have rendered them powerless. Dissensions among themselves, alienation of the Sunni population and rise of the Turkish chiefs first under the Ghaznawids and later under the Seljuqs destroyed their power.²⁹

These three dynasties marked the greatest expansion of the dynasties of Persian origin. Out of them, the Sāmānids and the Buwayhids thought it expedient to humour the rising nationalist feelings by claiming an ancient royal lineage. The rise of the Saffarids, a dynasty of low origin, showed the depth of the national sentiment which made people accept parvenus in preference to the declining Arab rule. Another factor was the Shī'ite proclivities of these dynasties, e.g., the Buwayhids, which made them popular with the growing Shī'ite tendencies in Iran and Khurasan. The rise of

these dynasties weakened the power of the Caliphate. While the Saffarids and the Samanids gained ascendancy in the distant regions of the Caliphate the Buwayhids demolished its power in Iraq and reduced the Caliphs to mere figure-heads. Thus these three dynasties were responsible for making the Caliphate innocuous in Iraq and Khurasan. The vacuum which followed from the collapse of the Caliphate allowed the Turkish chiefs to establish their suzerainty in these dominions.

The conversion of the Turks of Central Asia was a great event in the history of Islam. The first contact was established in the reign of the third Caliph, 'Uthmān. The first deep penetration was made by Qutaybah b. Muslim 711 A.D. Qutaybah's efforts established a nucleus of Muslim society in Samarqand.³⁰ However, the liberal policies of the 'Abbāsids (8th century A.D.) and the economic opportunities offered by the imperial military service, greatly accelerated the pace of conversion, particularly in those regions of Transoxiana which are now known as Russian Turkistan, e.g., Ashrūsanah. Thus it may be said that by the time of the Sāmānids, this region had been thoroughly permeated by Islam. The tenth century A.D. saw great breakthrough. Sātuq Bughra, the ruler of Kashghar, was converted to Islam through the efforts of Khwājah Abū Naṣr, a merchant missionary.³¹ Two hundred families also entered the fold of Islam along with him. Sātuq Bughra fired with missionary zeal and political ambition has been credited with uniting all the tribes east of Farghana upto the borders of China.³² Islam after uplifting the Arabs and the Persians, regenerated and united the Turks. However, it appears that the success of Sātuq Bughra was limited. Though tradition attributes the conversion of the U'ighūr Turks near the borders of China, to the period of Qutaybah b. Muslim (8th century A.D.) it seems, however, that either they still adhered to paganism or that their conversion was nominal; that they were still regarded as non-Muslim by their brethren in the west. It is said that Mahmūd of Ghaznah refused offers of matrimonial alliances of the Khān Īghur and Qatā (1026 A.D.).³³

Sātuq Bughra established the first indigenous Muslim dynasty of Kashghar. Their rise together with Mahmūd in the west and the U'ighurs in the east organised the Turks into three political units.

The U'ighurs were closely allied with the Chinese. The Īlak Khāns and other Turks in the west, on the other hand, looked south-westwards. Thus this phase of history in the great crucible of human evolution had reached a precarious melting point at the end of 10th century.

Rise of imperial power in China often generated pressure waves or pulsations, which reverberated from east to west and propelled the tribes of Mongolian desert into Transoxiana, Iran and Afghanistan e.g., the migration of Yueh-Chi, the Mongols, the Seljuqs etc. At the same time the cultural drifts from the Middle East and the sub-continent of South Asia sought to establish themselves, in the trans-Hindukush regions. The Transoxiana became a battleground between eastern and southern cultural pulls. Time and again, the Chinese tried to extend their sway over the whole region of Central Asia. The rise of Islam coincided with the establishment and expansion of the Tang dynasty. However, the Chinese met with a great reversal at the battle of Tarāz 751 A.D.³⁴ and the Turks were won over to Islam and the Muslim culture. The establishment of the Sung dynasty 966 A.D. witnessed another wave of Chinese expansion. The death of Īlak Khān (1012–13 A.D.) and the interne-cine strife over his dominion among his successors precipitated a large-scale Chinese attack.

However, Tughān Khān (d. 1017–18 A.D.) was able to beat back the Chinese.³⁵ The Turks were now free to give vent to their expansionist designs. Had the Turkish rulers of Kashghar succumbed to the Chinese attack, the rulers of Transoxiana, Khurasan and Afghanistan, facing the Chinese threat, would have little freedom of action. Mahmūd could not have his big empire. His expeditions to India also could have been jeopardized. Tughān Khān's victory also enabled Islam to progress eastward and consolidate earlier gains so significantly that the Mongol onslaught failed to change the socio-cultural pattern of these regions. Blocked in the east, the Sung dynasty started to move southward. The rulers of Kashghar gained popular support. The Ghaznawids and subsequently the Seljuqs had to look southward.

However, in the meantime the military strength and power of the rulers of Kashghar declined and Sultan Mahmūd was able to

extend his sway upto Samarqand (1017 A.D.). The Kashghar rulers although hanging on to a precarious existence, were compelled to play second fiddle to the Ghaznawids and later to the Seljuqs of Khurasan. Earlier Maḥmūd fearing the power of the Īlak K̲h̲āns overran and destroyed the K̲h̲w̲ārizmian kingdom. The rulers of Kashghar, out of fear, had to remain on friendly terms with Maḥmūd. Nonetheless, their presence persuaded Maḥmūd to divert his attention and seek expansion southward into the sub-continent.

This was the broad political setting in which al-Bīrūnī was born. There were, however, smaller dynasties as well who played an important role in blending the political life of the period and directly or indirectly influenced the life of al-Bīrūnī. One such ruling house was that of the Ziyārids of Jurjān (928–1042 A.D.) on the southern shore of the Caspian Sea. Almost inaccessible, it was never fully reduced by the Caliphate or the Sāmānids and became a seat of heterodox 'Alid doctrines. Its founder Mardāwij b. Ziyār, an indigenous prince, conquered Tabaristān, Jurjan, Isfahan, Hamdan and Halwan. He was the patron of the Buwayhids. His brother and successor paid nominal allegiance to the Sāmānids. After the rise of the Buwayhids, the Ziyārid domains shrank down to Jurjān and Tabaristān. At one stage their ruler Qābūs was compelled by Mu'ayyid al-Dawlah to live in exile for 18 years. Later they recovered Gilan and other dominions. In the end of century the Ghaznawids dispossessed them.

Another small but significant kingdom was that of K̲h̲w̲ārizm (Khiva). The K̲h̲w̲ārizm Shāhīs claimed descent from the former K̲h̲w̲ārizm Shāhīs who were defeated by Qutaybah bin Muslim in the beginning of the second decade of the 8th century. In the 10th century the family came to be known as Āl-i-'Irāq after one of their ancestors. Coins bearing the nomenclature of 'Irāq b. Maṣṣūr b. 'Abd Allāh Turksabasa (dated 960–977) have since been found. It was during his reign that Abū Rayḥān al-Bīrūnī was born. The Āl-i-'Irāq ruled only half of K̲h̲w̲ārizm with their capital at Kāth.³⁶

The other half was under Abū 'Alī Ma'mūn bin Muḥammad with Gargānj or Jurjāniya as his capital.³⁷

During the last decade of the tenth century when the Sāmānid empire was tottering, Abū 'Alī b. Abū al-Hasan Samījūr, a former

governor of Khurasan, tried to gain independence. At the same time Subuktgīn, the ruler of Ghaznah coveted Khurasan. Thus while Abū 'Alī opposed the Sāmānids, Subuktgīn feigned support to Amīr Radī b. Nūh, the Sāmānid ruler of Bukhara. Abū 'Alī secretly invited Bughrā Khān, the Turkish ruler of Kashghar, who drove out Radī and occupied Balkh (993 A.D.). Radī went to Āmil Shat (also called Amu, west of the Oxus, situated on the road leading from Bukhara to Merv). However, Bughrā Khān shortly afterwards fell ill, left Bukhara and died. Radī regained Bukhara.³⁸

As Ma'mūn and Abū 'Abd Allāh Muḥammad b. Aḥmad, the last ruler of the Khwārizmshāhiya had both helped Amīr Radī, the Amīr, asked Abū 'Alī the ḥakīm of Khurasan to give Nasā³⁹ and Abīward⁴⁰ to Ma'mūn and Abū 'Abd Allāh respectively. Abū 'Alī, probably, did not like to surrender the two regions. But he could not afford to antagonise the two neighbouring rulers in the north, while Subuktgīn was threatening him from the south-east. It appears that after assessing the situation, he decided to win over Ma'mūn, and gave him Nasā but kept Abīward with him. Abū 'Abd Allāh caught in between Ma'mūn's and Abū 'Alī's dominions, was helpless, but he could not forget the humiliation. The death of Bughrā Khān and the short-lived revival of the Sāmānids undermined the power of Abū 'Alī. After a prolonged conflict, Subuktgīn drove him out of Khurasan. The latter took shelter at Hazār Asp near Kāth (995 A.D.) Abū 'Abd Allāh on learning this, lured out the fugitive chief and imprisoned him. Having heard of the sad plight of Abū 'Alī the erstwhile ally of the Farīghūnids, Ma'mūn, who was in all probability waiting for a pretext to invade Kāth, marched out on the plea of avenging the defeat of his ally. Abū 'Abd Allāh was killed and the whole of Khwārizm passed into the hands of the Ma'mūnids. Abū 'Alī was sent to Bukhara where he was also executed. The death of Abū 'Abd Allāh ended the family of Āl-i-'Irāq. Al-Bīrūnī, the protege of the Khwārizmshāhis, was thus forced to seek shelter somewhere else.⁴¹

Ma'mūn was succeeded by his son Abū al-Ḥasan 'Alī (997 A.D.). It seems that the Ghaznawids having acquired Khurasan found the rapidly growing might of the Ma'mūnids menacing. Their own conflict with the Hindūshāhis and the increasing power of the rulers

of Kashghar threatening Transoxians and Khurasan could also have persuaded them to cultivate friendly relations with the rulers of Khwārizm. Kah-Kālji, a sister of Maḥmūd, was given in marriage to Abū al-Hasan. In 1008–9 A.D. Abū al-Hasan died, and was succeeded by Abū al-‘Abbās, who being desirous of winning the friendship of the powerful Maḥmūd, secured the latter’s permission to marry his widowed sister. Abū al-‘Abbās also exercised tact and diplomacy to keep his ambitious and dangerous brother-in-law in good humour. He never displayed the *sanad*, the ensign and titles of ‘*Ayn al-Millah* and *Zayn al-Millah* received from the Caliph. He started his drinking parties in the name of Maḥmūd. However, these professions of friendship failed to produce the desired effect, rather the over-eagerness of the Ma’mūnid prince may have aroused Maḥmūd’s suspicions. Maḥmūd feared a possible alliance between the Ma’mūnids and the Īlak Khāns of Turkistan. An independent friendly state also could not fit in with the imperial designs of the Ghaznawid ruler. Therefore, a conflict between the two was only a matter of time. The first cleavage seems to have appeared with Maḥmūd’s request for Abū al-‘Abbās’ participation in his peace negotiations with the Turkish chiefs of Transoxiana in 1012 A.D. Abū al-‘Abbās sent an evasive and diplomatically couched reply, excusing himself by stating that he was a partisan of Maḥmūd and therefore his participation would be of little use. Maḥmūd was not satisfied. On the advice of his *Wazīr* Aḥmad Ḥasan Maymandī, Maḥmūd decided to test Abū al-‘Abbās’ sincerity by suggesting open allegiance by reciting his name in *Khutbah*.⁴² Ma’mūn reading the real meaning behind the message and unable to challenge Maḥmūd’s power, sent Ya‘qūb Jundī to ask for a formal request so as to comply with it. Jundī who probably belonged to those Khwārizmians who were opposed to Maḥmūd, mismanaged and bungled the whole affair. Threats from Ghaznah followed the failure of the mission. Ma’mūn desperately tried to persuade his chiefs to accept Maḥmūd’s demand. The latter refused and threatened to rebel. They were pacified with difficulty through the good offices of al-Bīrūnī with hopes of reward and on the plea that the prince was testing their loyalties. Abū al-‘Abbās was placed in an extremely embarrassing situation. He feared Maḥmūd’s reprisals. Maḥmūd’s expedition to

Hind (India) provided a short respite. On the advice of al-Bīrūnī who had returned to Khwārizm after a period of wandering, Abū al-'Abbās tried to strengthen his position by ingratiating himself with the Turkish chiefs of Transoxiana. Al-Bīrūnī used his good offices and arranged peace between the chiefs and the Īlak Khān. Maḥmūd, returning from India, heard about the peace and wrote to the Khāns; for he wanted the Turkish chiefs to remain hostile to the Īlak Khān. The chiefs replied that as the peace was arranged by the Ma'mūnid prince, a friend and relation of Maḥmūd, they agreed to abide by it. They also cautioned al-'Abbās of his untenable position and tried to patch up the rift between the two. Maḥmūd assured them of his peaceful intentions but continued his military preparations. He was determined to punish al-'Abbās for his involvement with the neighbouring Turkish chiefs. Friendly relations among the Ma'mūnids, the Turkish Khāns and the Īlak Khān could be a foreboding for a possible formidable alliance against Maḥmūd. The Ghaznawid Sultan assembled one hundred thousand troops and collected five hundred elephants at Balkh. However, on the recommendation of the Turkish Khāns, Abū al-'Abbās was asked to choose one of the following three conditions: to recite the name of Maḥmūd in the *Khutbah*, send some suitable presents which would be returned secretly afterwards, or the *ā'immaḥ* and *faqīhs* (the learned men and jurists) should request Maḥmūd to go back. It seems that Maḥmūd still did not wish to annex the dominions of his brother-in-law and wanted only a token allegiance. 'Abbās tried to compromise and decided to recite Maḥmūd's name in *Khutbah* in all his territories except Gargānj and Khwārizm, and to send eighty thousand *dīnārs* and three thousand horses with *mashā'ikh*, *quḍāt* and *ā'yān*. This arrangement would have satisfied Maḥmūd and kept a semblance of self-respect for the Ma'mūnids by restricting the recitation of Maḥmūd's name. Satisfied, Maḥmūd went back.⁴³

However, anti-Maḥmūd feelings among the soldiers and chiefs ran high. Probably the craving for freedom, and their disinclination to bow before the might of the imperial power of Ghaznah had stimulated a general opposition to Maḥmūd. The *hājib buzurg* Alaptgīn Bukhārī with three thousand *swārs* under him was stationed at Hazār Asp. He saw an opportunity to seize control. One day.

heading a group of soldiers, he paid a visit to the palace and came out with the information that 'Abbās was dead (17th March, 1017). The rebels proclaimed one of the sons of the late prince aged 17, as ruler.⁴⁴ According to another version they raised Abū al-Hārith Muḥammad 'Alī to the throne. Alaptgīn unleashed a reign of terror which lasted for four months.

Mahmūd, after a war council, decided to avenge his brother-in-law's tragic death. In fact his own prestige was involved. The defiance of Mahmūd's authority by a small group could start a chain reaction. But at first he secured the neutrality of the Turkish Khāns, and ensured the safe return of his widowed sister. Mahmūd advanced up to Balkh. The Khwārizmians, failing to secure an honourable peace, decided to oppose Mahmūd and mustered an army of 50,000. The Sultan, moving his army through the river route, made a surprise thrust on Gargānj. The Khwārizmians made a night attack on Mahmūd's advance guards. The situation was saved for the imperial army by the royal bodyguard contingent and the Khwārizmian commander Khumār Tāsh was captured. Next, Alaptgīn and his army was crushed although the latter managed to put up a valiant resistance. The members of the Ma'mūnid family were taken captive. Mahmūd severely dealt with the regicides, who were physically incapacitated or killed. The Ma'mūnids were finally sent to India. It is said that five thousand people were taken prisoners to Ghaznah. Probably they included Abū Rayhān al-Bīrūnī who had been responsible for the involvement of 'Abbās with the Turkish Khāns.⁴⁵

The last but the most important of all these dynasties was that which was established by Subuktgīn at Ghaznah. Alaptgīn, one of the Turkish slave chiefs of the Sāmānids, became governor of Balkh and commander of the forces of Khurasan in the reign of 'Abd al-Malik b. Nūh (954-61 A.D.). After his patron's death, he was unable to enthrone his nominee. The new *amīr* Abū Maṣṣūr Muḥammad forestalled Alaptgīn's advance on Bukhara. The latter finding his position in peril escaped to Ghaznah (962 A.D.) and captured it by driving out the Lawīks, the erstwhile rulers of that place. He soon reduced Bust and a part of the kingdom of Kabul. But he died soon afterwards. A rapid succession of rulers followed

Abū Ishāq Ibrāhīm (961–64 A.D.), Baliktigīn (964–75 A.D.) and Piritigīn (975–77 A.D.).

As Piritigīn failed to meet the joint threat of Abū 'Alī Lawīk, the son of the former ruler of Kabul, Subuktigīn who defeated them was elected as the ruler.^{4 6}

Abū Mansūr Subuktigīn occupied Bust and Lamghān. A conflict with Jaipal, the Hindūshāhī ruler of Lamghān and the territory up to the Chenab, was brewing. A clash with Alaptigīn had already taken place. The ruler of Kabul had supported the house of Lawīk against Piritigīn. In the ensuing battle Subuktigīn commanding the army of Ghaznah had captured both Abū 'Alī and the sons of the king of Kabul. Subuktigīn's incursion after his accession brought about a clash. Jaipal was defeated and promised to cede some forts. Since he went back on his word, Subuktigīn occupied some portion of Lamghān. In the next battle Jaipal was again defeated and Subuktigīn conquered the whole region between Lamghān and Peshawar. Taking advantage of the quarrel between the Sāmānid ruler and his Khurasanian governor Abū 'Alī Samījūr, Subuktigīn annexed Khurasan and received its confirmation from the Sāmānid ruler.

Subuktigīn was succeeded by his son Maḥmūd. During his reign, the Sāmānid rule was finally abolished by the Īlak Khān. Thus Maḥmūd substituted the Sāmānids as the *de jure* as well as the *de facto* ruler in Khurasan and Central Asia. His rise, together with the Īlak Khāns of Kashgar, symbolized the political maturity of the Turkish people whose strength and political acumen was manifest for a long time but had remained unrealized hitherto because of disorganization. A number of results flowed from the rise of these two powers. Their struggle for supremacy in Transoxiana led to the destruction of the smaller principalities such as Khwārizm. They also served as a check on each other's expansion. Thus both of them failed to develop into a great empire uniting all the Turkish people of Central Asia.

However, their presence curbed the fissiparous tendencies of Turkish chiefs and transformed anarchy and chaos, through coalescence, into great empires, e.g., the Seljuqs, Mamluks of Egypt, the Ottoman Turks, the Turkoman Safawid, the Sultanate of Delhi and

the Mughul empire of the sub-continent. In fact, the Turks became the guardians of Islam. They had supported the 'Abbāsid Caliphate. In the 10th century they checked Chinese expansion into Central Asia. Later they, as the Mamluks of Egypt and Sultans of Delhi, stopped the Mongol steam-roller from overwhelming Egypt and India. They also wrested Palestine from the Crusaders. When the Mongol power subsided, the Turks reasserted their predominance under Tīmūr. In this way the conversion of the Turks to Islam, their dispersion all over the regions of Islamic Asia and Egypt and their inherent quality of empire-building was the most important development of medieval Islam after the 9th century A.D. It was the third great racial drift in Islam after the Arab and Persian ones. It coincided with the third integration of Islamic society under orthodoxy, for the Turks were orthodox Sunni Muslims. The final evolution of the Muslim society and state therefore owes much to these hardy warriors of Central Asia.

Nevertheless, the rise of imperial tendencies among the Turks encountered some resistance in the beginning. Maḥmūd had to humour the Turkish Khāns who were opposing the Īlak Khāns. The Khwārizmian Turkish soldiers were averse to acknowledge even nominal suzerainty of Maḥmūd.

The rise of the Īlak Khāns checking the expansion of Maḥmūd's dominions in Central Asia conditioned Maḥmūd's military career. In Central Asia all his efforts were directed to counter-balance the Īlak Khāns while the old conflict between the Turkish rulers of Ghaznah and the Hindūshāhīs⁴⁷ offered him full opportunities to satisfy his expansive proclivities which led to the annexation of the Punjab and to the inflicting of deep and penetrating blows against the allies of the Hindūshāhīs. Maḥmūd's military genius, thus, created a large empire extending from Rayy to the Punjab and from Samarqand to Makran. Again a trans-Hindukush empire was created uniting Iran, Central Asia and Western India.⁴⁸ It enabled Abū Rayḥān al-Bīrūnī to come into contact with Hindu scholars of the Punjab and Kashmir. However, the empire of Maḥmūd was a military imperialism based on the deployment of mercenary troops; and its administrative structure therefore remained weak. It did not command the loyalties of any great tribe of the Turks. These factors

combined with the rising power of the Seljuqs and military mistakes of Mas'ūd, who belittled the Seljuq threat in the beginning, led to the loss of the Transoxianian and Persian provinces. Mas'ūd himself was assassinated in (1040 A.D.). The Yemeni dynasty went on decaying till Lahore, its last hold, was taken over by the Ghorids in 1161 A.D. Therefore, it may be said that by the last quarter of tenth century A.D. the political conditions in Khurasan and Central Asia were heading towards the evolution of Turkish empires. The Sāmānid dynasty after a long prosperous rule was nearing the end of its life. The long struggle between the Caliphate and its regional and ethnic components were over. A new imperialism was taking the place of the old order. The Turks were the new rising power in the eastern lands of Islam. The territorial ambitions of the Turks led to the second stage of contact between the Muslim world and the sub-continent. It enabled al-Bīrūnī to acquire knowledge of India, her peoples, religions and traditions.

NEW SOCIO-ECONOMIC ORDER

Before the unification achieved under the driving and dynamic force of Islam, the vast area which later came under the Caliphate, comprised three separate economic and political units, viz., the Byzantine empire, the Iranian (Sassanids) empire and the Arabian peninsula. The two empires controlled some portions of the Arabian mainland as well. Except the semi-nomadic and isolated regions of the Arabian mainland, the whole area was under an aristocratic and feudal social structure supporting an imperial order. The general mass of the people including the merchants and the agriculturists were exploited. Society had become stratified and fossilized. Caste and class considerations rather than ideals of country, nation or humanity, became the motivating factors. In Iran, for example, the Sassanids came to power as a caste reaction in 226 A.D. This feudal system was creating an over-concentration in the hands of the aristocracy (military and religious) while differences among the lower castes were being ironed out creating a great mass of the exploited people. Thus Bertold's contention that the impact of the 'foreign' culture of Islam was responsible for the disintegration of the castes

and the blurring of their distinctions demands further elaboration.⁴⁹ The process had started earlier and a confrontation had already taken place under the guise of Muzdakite communistic doctrines, in the reign of Nawshīrwān. The Muslim conquest, however, gave a clear conception of a classless and casteless society. In this sense Bertold's contention cannot be regarded to be correct.

Another characteristic feature of this society was the extensive use of slavery in army, industry and in agriculture. With the help of slaves the feudal class consolidated its own position and wealth vis-a-vis the agriculturists, the artisans and the traders. However, the condition of these slaves was appalling and there was little hope of their redemption from the existing socio-religious and economic order.

The religious minorities, e.g., the Jews and the Nestorian Christians in the Byzantine empire and the Manichaeans and the Muzdakites in Iran were subjected to constant persecution. Consequently they fled to safer places. The Nestorians and the Jews sought shelter in Arabia or in Iran while the Manichaeans dispersed, and with Muzdakites spread among the nomadic Turkistan and thence into China. So far-flung was the migration of the minorities that St. Augustine (354—430 A.D.) in his youth was a Manichaean.

The position of women was no better than that of slaves. They were denied any protection against the tyranny of man and were treated like chattels or items of property.

Arabia, though outside the pale of imperial social structure, had a tribal-cum-feudal system of its own in which tribal chiefs and their families enjoyed a privileged position. The tribes in possession of settled colonies around oases or spiritual sanctuaries looked down upon the poor desert-dwelling Bedouin. Intense tribal rivalry led to anarchic conditions in every aspect of life, trade and commerce, and morals, conditioning the semi-urban and predominantly nomadic economy to remain at the bare sustenance level.

In the fertile crescent of Syria, Iraq and Iran, the above mentioned conditions had further deteriorated by the intense wars between the Byzantine and Iranian empires recalling to mind earlier Hellenistic and Syriac-Iranian struggle.

As the fossilized feudal structures of the continental empires

precluded any reform or revolution undermining the powers of the aristocracy and severely crushed such attempts as the anti-property and anti-family athiestic Muzdakite doctrines, the semi-feudal and tribal life of Arabia, lacking any great political administrative machinery to sustain the privileged classes, proved in a way less difficult of access to new socio-economic and religious ideas put forward by the Prophet Muhammad (peace be on him). His revolutionary ideals were based on the great idea of equality and fraternity (the stimulating power behind all the great revolutions that have stirred mankind, e.g., the American (1776), the French (1789) and the Russian (1917) Revolutions, with a new socio-economic social order based on brotherhood, measures against permanent concentrations of wealth, and orderly family and social life.

The new order tolerated only one division of humanity, i.e., the believers and non-believers. In order to provide economic incentive and believing in an economic system with minimum taxation, Islam introduced a preferential taxation structure. This was the first universal use of taxation policy to achieve goals of socio-economic welfare.

However, the progressive nature of Islamic taxation policy was nullified by socio-economic and political developments. The goals of a welfare society and democratic spirit were replaced by a parochial and racial imperialism with a feudal set-up.

The rise of this imperial power under the Umayyid accelerated the formation and completion of an Arab aristocracy whose origin can be traced back to the days of the Pious Caliphate. The inflow of unlimited wealth and manpower in the form of slaves in the reign of the second and third Caliphs created a serious socio-economic crisis. The second Caliph 'Umar bin Kḥattāb tried to maintain the equilibrium of the society and keep intact the concept of socio-economic equality in three ways. He tried to keep the distribution of *ghanimah* under control, attempted to stop wars and forbade the Arabs to settle down and acquire lands outside Arabia. In the face of continued expansion of the Caliphate and clamour of the younger, ambitious generation of Muslims, these restraints proved difficult to be maintained in the next reign. The third Caliph Uṭhmān b. 'Affān tried to solve the problem by changing the policy

of his predecessor and allowed the Arabs to exchange their lands with those of other countries. Large scale exchanges followed, converting the Arab chiefs into landed gentry in the whole of the Caliphate and putting a premium on Arab stock. This was the first serious clash between the concept of equality and vested parochial and tribal interests. In the end the conflict destroyed democratic traditions, the idea of equality was eclipsed and from its ruins rose the phalanx of the military power of the Umayyids. The imperialists consolidated their own position by strengthening the nascent feudal structure. Besides the Arab aristocracy, the Arab masses also acquired a privileged position. Islam accepts only two classes, the Muslims and the non-Muslims. It aims at world revolution and provides incentives for the conversion of non-Muslims. But in the feudal set-up concessions were transformed into privileges of the believers only. Some of the Umayyid rulers afraid of the increasing number of new Muslims and also disliking any decrease in their incomes by conversions to Islam discouraged proselytization. This policy allowed the Arabs to remain the dominant group among the Muslims and to monopolize the economic and socio-political status. In the early stages the Arabs were the only Muslims and, therefore, generally all the offices of the state were acquired by them. The Umayyids in an attempt to make their imperialism palatable to the Arabs, humoured the latter by converting this accidental development into a permanent policy and reserved government jobs for the Arabs only. The position and advantages enjoyed by the early warriors of Islam as being Muslims were later denied to the non-Arabs. An Arab hegemony with a hierarchical set-up came into being. At the top was the Umayyid clan followed by the Quraysh, the other Arab chiefs and Arab masses lineally. These Arab masses consisting of the desert people who were nearer to their narrow pagan parochialism, began to pride themselves as the first of the Muslims in comparison to non-Arab Muslims and developed an intensely exclusive and isolationist outlook.

The Arabs were followed down by the newly converted Muslims and at the last step of the ladder were the *dhimmis* or the non-Muslims. Notwithstanding the discouraging policies of the Umayyids the exploited castes and classes in the non-Arab regions attracted by

a better religion and in order to escape the past indignities of their social position, continued to embrace Islam though in lesser numbers than in the period of the Pious Caliphate or under the 'Abbāsids. In this way Islam spread in Iran and among the Berbers. With the passage of time the number of new Muslims increased and they began to clamour for the equality promised by Islam. However, they were compelled to pay *jiziyah* as well as *kharāj* by some of the Umayyid rulers. They fought in the armies of the Caliphate without receiving any salary or stipend for their families. The Iranians, however, conscious of their ancient glory, were loath to accept the supremacy of 'desert' Bedouins.

The local aristocracy such as the *dihqāns* and the *marzabāns* were unhappy at their loss of pre-eminence. Denial of the equal rights promised by Islam inclined these people to accept the messianic and heterodox movements promising an amelioration in their conditions. And such a messianic teaching also approximated to Zoroastrianism. This discontent of the non-Arab Muslims first noticed in the reign of the Caliph Uthmān at Kufah and Basra where the non-Arabs outnumbered the Arabs, was bound to gather momentum with the passage of time. The revolutionary concept of equality had produced the first clash in the Arab society in the lifetime of the Prophet when the Arab tribes had to accept its theory as well as practice. During the Umayyid rule the clash between the ideal of equality and Arab imperialism crystalized into a racial and regional confrontation between the Arabs and the non-Arabs and between the rich provinces of Khurasan, Syria, and Africa (including Egypt) for the control of the Caliphate.

It was only a question of time how long the Arabs could hold out against the other two ethnic groups, the Iranians and the Berbers. The imperial and feudal set-up in fact worked against the Arabs themselves. The Arab masses were also exploited. The feudal classes monopolized all the important posts. As selection on merit was replaced by nepotism, unworthy people who could not realise the magnitude of the crisis facing them came to the fore. Monopolization of jobs recoiled upon the Arabs by re-awakening the latent tribal jealousies. An era of civil war among the Arabs was unleashed, impairing the Arab dominance. The newly converted Muslims under

the 'Abbāsīd and their able agent Abū Muslim Khurasānī seized the opportunity and overthrew the Umayyids.

The non-Muslim people of the books (including Majūsis or Magians and later the Hindus and the Buddhists of Sind) had been regarded as the responsibility of the Muslim state and therefore enjoyed the protected status of *dhimimīs*. The conversions to Islam made them a diminishing group. As most of the conversions to Islam were generally from the oppressed classes, in the remaining group the ratio of the feudal class to the masses improved. Gradually a hard core was left and it sought shelter in difficult areas and managed thereby to survive longer. This decrease in their numbers was greatly accelerated under the 'Abbāsīd rule till the whole of Iran and Transoxiana was won over by Islam except a few isolated pockets. Had this been not the case and the majority of the Khurasanis were non-Muslims, the 'Abbāsīds would have been accused of being in league with the pagans. This could have alienated Muslim support in other regions and could have jeopardised their chances of creating hegemony.

The 'Abbāsīds were mainly dependent for their success upon the support of the newly converted Muslims. An increase in their numbers meant greater stability for their rule. Hence the 'Abbāsīds adopted two reforms which had been initially introduced by Naṣr b. Siyār, the last Umayyid governor of Khurasan. They were related to the removal of disparity in land revenue and emoluments given to the Muslim soldiers. Thus the old economic incentives of Islam were revived and the number of non-Muslims further decreased. This change greatly affected the Turks of Transoxiana who were increasingly attracted to Islam. The employment opportunities provided by the 'Abbāsīd Caliphate brought in hordes of Turkish chiefs and soldiers to the fold of Islam. These migrations included the frontier regions of Daylam, Tabaristān, Afrūshnah etc. The vacuum in these regions induced the other Turks living far inland to move to better places. Thus the whole of the Turkish people were in a state of flux.

Another noted characteristic of this society was the use of slavery. Islam tried to make the conditions of slaves as humane as possible and provided incentives for the gradual abolition of the system, for a sudden ban without removing the factors responsible

for the creation and existence of the evil would have been futile. Muslims vied with each other in freeing slaves. 'Umar I forbade enslaving of the Arabs (the early Muslims). However, with the passage of time and adverse conditions, total ban on slavery, the goal inherent in the liberal policy of Islam, could not materialize. Nevertheless, the liberal treatment of slaves as laid down by Islam continued. Extensive use of slaves in armies and administration transformed slavery into an institution of recruiting the best talent. Training slaves for state jobs became a lucrative business. This was particularly true of the period when there was a large influx of Turkish slaves. Thus slavery, no doubt, strengthening the monopolistic and feudal tendencies in society gradually became a means of socio-political ladder of promotion for the non-aristocratic classes. The stigma and indignities associated with slavery were lost when slave-rulers and warriors such as the rulers of Ghaznah and the Mamluks of Egypt emerged. Most of these slaves were recruited for their accomplishment. They were in their turn able to appreciate and encourage literature and science. As slaves and sons of slaves they were to excel and outshine the free-born chiefs and sultans so as to justify their claim and power over thrones.

The Pious Caliphate and the rule of the Umayyids was characterized by a large-scale urban development. Generally these new cities came into being due to military exigencies. The Arabs with their limited number of warriors established Junds (military cantonments). These cities became centres of Arab-Islamic culture and were one of the contributory factors in the spread of Islamic culture. As most of these cities e.g., Kufa, Basra, Fustāt, Kairowan, Wāsiṭ, Ramlah, Ruṣāfah, Muḥfūzah, Maṣṣūrah and Baghdad, were situated at strategic cross-roads, they soon developed into trade centres. They played an important role in the political movements which were often centred in them. Their importance along with the greater opportunities and facilities that they offered attracted a large number of people. Migration from the countryside towards cities started on such a large scale that Ḥajjāj had to take measures to check it. The stabler conditions provided by the Caliphate and large scale trade gave a fillip to their progress and in time, under patronage of rulers and provincial chiefs, these cities became centres

of art and learning. The town people with their wider contacts and broader outlook were more receptive and ready to accept new learning and knowledge.

A continuous era of prosperity marks the long era of the Caliphate. This was partly due to the stable and peaceful conditions obtaining in the Muslim society. The minimum and clearly defined taxes were an incentive to the farmers and the traders to make greater efforts. An interest-free capital formation, the sharing-in of the wealth in the form of *Zakat* – an anti-hoarding measure – and the principle of the division of property ensured a proper capital formation, a necessary base for further investment, and also provided for the rotation and circulation of wealth. The rulers generally followed a policy aimed at encouraging such developments. Canals were dug, swamps were drained. The vast but united area of the Caliphate with better and safer communications, with Arabic as the lingua franca and a common currency provided an international market to the ambitious and the enterprising. Great regional specialization in products occurred and the vast Caliphate became one economic unit. Regions such as Khurasan and Transoxiana not only became rich but also self-sufficient.

Thus an unprecedented era of the development of trade and commerce was ushered in. The imperial and city life provided new markets. The Arabs were already international traders and their activities ranged from the Far East to Europe. This trade was carried on the sea or by land routes. The ancient trade routes hummed with life as never before and the regions and cities situated along them gained in prosperity. They became centres of commerce. They borrowed crafts and industries from distant lands and became important industrial centres. One such route linked Syria and Mesopotamia with Iran, Central Asia, India and China. Radiating from Baghdad it meandered through Khurasan and Transoxiana. Another branch connected Baghdad to Nasyabur (Nishapur), Merv, Bukhara and Samarqand. A branch from Merv crossing Khurasan in the middle reached Balkh and crossing the Oxus at Tirmidh went upto Farghanah. Another road connected Nishapur to Shiraz. In this way most of the important centres of Khurasan and Transoxiana were interconnected with each other and also with the

great trade artery spanning the whole of Western and Central Asia.

This economic activity was seldom affected even by political upheavals, for the rulers knew that steady trade was an asset and therefore generally tried to protect the farmers and the traders. In time the economic system became so strong and stable that temporary checks in the form of wars were rapidly overcome.

Economic stability continued and reached a high level of development in the tenth and the eleventh centuries and of the Christian era. This is particularly true of Khurasan and Transoxiana. Out of all the different provinces of the 'Abbāsid Caliphate, Khurasan was among the three richest provinces, the other two being al-Sawād and Egypt. The break up of the Caliphate was a political change and the new local dynasties with greater resources than the provincial governments of the Caliphate provided greater impetus to agriculture and trade. The rulers possessing Khurasan and Transoxiana, e.g., the Sāmānids and the Ghaznawids, were noted for their wealth and prosperity. The Ghaznawid expeditions to India brought in large surplus wealth to these regions. Strong rule, its stability, and contacts with the Muslim world, India and China, made this region a great centre of trade and commerce. The increasing wealth of the rulers enabled them to patronize scholars. Thus scholars even from Baghdad were attracted to these regions and those who came here seldom left.⁵⁰

As discussed above, Khurasan and the environs were amongst the most prosperous regions of the Caliphate. Under the rule of the Tāhirids, the first local dynasty, Khurasan was very prosperous.⁵¹ Istakhrī (951 A.D.) said that Transoxiana was not only rich and economically self-sufficient⁵² but endowed with beauty and culture that was unparalleled. Bukhara was the most beautiful of the cities and possessed ten thousand caravan sarais which provided food and fodder for the travellers and their animals. The *iqīm* (Transoxiana) possessed three hundred thousand villages which could produce and maintain twice its number of foot and horses. Qazwini (1275 A.D.) remarks on the beautiful regions of Transoxiana, brimming population, extensive cultivatable lands, pastures, good water and a salubrious climate. Bukhara, Jand and Khujand were its celebrated cities. The people were peace-loving and united as members of one

family.⁵³ Al-Idrīsī (12th century) had already mentioned a number of exports from this region in the Sāmānid era.⁵⁴ As Khurasan and Transoxiana were situated along the caravan route linking China and West Asia, they were able to borrow techniques from both sides. Thus Khwārizm produced fabrics designated Dabighi and Athmuni after the celebrated textiles of Egypt. Samarqand already possessed a flourishing paper industry. The fine craftsmanship of China was an acknowledged tradition and any fine piece of workmanship was designated *Al-San'at al-Sīn*.⁵⁵ However, gradually these regions became so advanced in industry and crafts that they began to export goods to China during the 9th and 10th centuries A. D. Some of the exportable items were armour, swords, shields, textiles etc.⁵⁶ According to Maqdisi the trade and commerce of *Mawrā' al-Nahr* surpassed that of Basra and Baghdad.⁵⁷

Out of these towns Bukhara, Ṭabaristān, Raḥīm Jān, Khwārizm, Qāqum, Samarqand and Sashī appear to have been the chief industrial and mercantile centres. Most of them possessed diversified industries, while some of them exported raw materials as well. Specialization in various fields was in evidence.

An idea of this industry and trade may be obtained from the following list:⁵⁸

| <u>Place</u> | <u>Products</u> |
|-------------------------|---|
| 1. Tarina | Soap and asafoetida. |
| 2. Bukhara | Fine fabrics, carpets, copper lamps, shades. |
| 3. Ṭabaristān | Textiles, saddles, pots, sheep leather, oil, others (perfumes). |
| 4. Mānia | Kerchiefs. |
| 5. Dabūsiyah and Wadhar | Textiles (Wadhari or Atlas-i-Khurasānī). |
| 6. Raḥīm Jān | Red woollens for winter, leather, tin goods, shawls. |
| 7. Kabrīt | Ladies' fabrics. |
| 8. Khwārizm | Ladies' clothes, grapes, chestnuts, cushions, blankets, silk, ready-made clothes, shawls, strong bows, butter, fish, athmuni textiles, shoes. |
| 9. Sumar | Leather. |

- | | |
|---------------|--|
| 10. Qāqum | For leather, river dogs, rabbits, torches, bark of san, arrows, bows, swords, long leather caps, tanned horse leather, oil and teeth of fish, amber, honey, hawks. |
| 11. Salafiah | Slaves. |
| 12. Samarqand | Embroidered cloth, tents, saddle and reins, copper utensils, woollens, paper. |
| 13. Banakit | Products of Turkistan. |
| 14. Sashi | Saddle, book binding, paper, tents, prayer carpets, tanned leather, leather caps, needles, bows and scissors. |

During this period the wealth of Tabaristān, Khwārizm, Bukhara, Samarqand and Sashi was so great that their chiefs enjoyed a surplus wealth and were in a position to encourage learning similar to the city states of Italy on the eve of the Renaissance, notably Florence and Venice. Formerly even surplus wealth had to be sent to the Caliph's treasury.⁵⁹ This surplus wealth allowed them to patronize scholars and foster learning. In the reign of the Ghaznawids, the wealth from Hind and that of Khurasan and Transoxiana were pooled together and allowed Maḥmūd and his sons to bestow elephant-loads of silver and other gifts to scholars. However, influx of such a huge amount of wealth could have generated inflationary tendencies but as most of this wealth remained closed in the coffers of the Sultans, no undesirable tendency was noticed.

RELIGIOUS BACKGROUND

Before Islam, Christianity in the Byzantine empire, North Arabia, Yemen and Ethiopia and the doctrines of Zartušt in the Sassanid empire were the two chief and official creeds. However, there were a number of schismatic and minority groups such as the Jews, the Buddhists, the Manichaeans, the Muzdakites, the Mandeans, and some Christian groups like the Nestorians, the Copts, the Sabeans. In Arabia the majority of the people were idol worshippers. The rise of Islam posed a serious challenge to these religions and they wore down under its impact. Their following, except some small groups, retreated into difficult terrain like the

Jabal area in Khurasan. Some of them used to live disguised as Muslims till as late as the eleventh century. In this conflict with Islam the beliefs of Zartusht and Christianity were the main sufferers. However, the Manichaeans who had been earlier persecuted by the rulers of Byzantium and Iran, found the new religion too powerful and remained dormant for some time. The internecine conflict marking the rise of the 'Abbāsids enabled them to gather strength. This is why the 'Abbāsids had to devote special attention to their suppression.

With the expansion of the Islamic dominions dissensions and differences arose. Clash between the concept of equality and justice in Islam and Arab parochialism repeatedly engulfed the Muslim world in socio-political upheavals. The nascent democratic tendencies were unable to withstand the emerging imperial trends. These conflicts became polarized in the problem of succession to the Caliphate. The clash developed into a struggle between the Hāshimītes and the Umayyids. Its immediate result was the split of the Islamic world into three groups, viz., the supporters of the Umayyids, the supporters of 'Alids or Hāshimītes, and the Khārijites. Later the 'Alids opposing the Umayyids developed mainly into the sects of the Shī'ites and the Ismā'īlis. These differences enveloped the whole of the Caliphate. The sha'ūbites discontented with the Arabs were attracted by the propaganda of the approaching end of their miseries by the promised appearance of the Mahdi. In this way racial, political and economic conflicts rent asunder the political hegemony of the Arabs and also gave birth to a number of religious-cum-regional developments.

It has been suggested that Abū Rayhān's detailed information about these non-Muslims was due to the existing majority of these beliefs. The Khurasanians were largely instrumental in bringing the 'Abbāsids into power. No doubt that the followers of Abū Muslim Khurāsānī included even non-Muslims such as Sanbād (8th century A.D.) Nevertheless had the non-Muslim Khurāsānīs been in majority, the 'Abbāsids would have faced the charge of being in league with the heathens. Their whole movement would have collapsed by alienating the sympathies of the Muslims. The rebellion of Bābak Khurramī (816-38 A.D.) was the last revolt of these non-Muslims.

Except for the people of the Jabal none of the provinces of Iran reported any large scale rebellion by the non-Muslims.⁶⁰ The Manichaeans (the *Zindīqs*) were the main groups which faced persecution during the 'Abbāsid rule. They were already a minority before Islam was founded and were dispersed in Iran, Iraq and Syria. The orthodox, Abbāsid Caliphs who persecuted the *Zindīqs* and did not countenance the Rāwindyahs (the believers in the divinity of the 'Abbāsid Caliphs), could not have tolerated the non-Muslim majority of Iran. The expansion of Islam into Transoxiana was slower. The invasion of Qutaybah (711 A.D.) introduced Islam into the heartland of Turkistan. However, some of the Umayyids, fearing loss of revenue, discouraged conversions. The 'Abbāsids relying for their power on the non-Arab Muslims encouraged conversions. Thus during the 8th and 9th centuries people of the regions of Bukhara and Samarqand and the regions closer to Iran became Muslims. The next break came when the rulers of Kashghar became Muslims in the 10th century and united all the Turkish tribes east of Farghana upto the border of China. The U'ighurs, the important Turkish group between Farghana and China, were reportedly converted during the 8th century. Mahmūd actively persecuted the Ismā'īlīs of Multan and Sind. However, during his conquest of Khurasan and Transoxiana there is no reference to any conversions of non-Muslims. At the same time Maqdīsī described the people of Transoxiana as people of *khayr* and *salāh*. In religious and other affairs the people, everywhere, appeared to belong to one family. Qazwīnī found the atmosphere congenial because the people were of his religion i.e., Islam.

Generally the religious beliefs of a people were decided by the beliefs and policies of the rulers. The persecution of *Zindīqi* heresy and the adoption of the Mu'atazalite doctrines by the 'Abbāsids illustrate the above point. However, it may be pointed out that the above-mentioned factor dealt only with the legal supremacy of one or the other beliefs. Forcible imposition of any beliefs by the ruler generally met with strong resistance and sometimes led to the triumph of the popular beliefs i.e., the victory of orthodox beliefs against the Mu'atazalites.

Under the 'Abbāsid rule during the 8th and 9th centuries a

number of distinct religious tendencies may be seen. On the one hand, the need for the modification of Islamic laws and their interpretation in the light of new developments gave birth to the five main schools of jurisprudence, the Ḥanafī, the Mālīkī, the Shāfa'ī, the Ḥanblī and the Imāmīyah or Ja'fariyah.

The acquaintance with philosophy, logic and other Greek sciences brought into being new tendencies and developments. Controversies arose about the nature of the *Qur'ān*, the *Wahī* (revelation), soul and God. Academic differences evolved into definite doctrines. There arose the Qadiriyyah or the Mu'atazilite school of thought. They won over the Caliphs al-Ma'mūn, Mu'tasim and Wāthiq (813–842 A.D.). After three decades of supremacy the Mu'atazilite beliefs began to decline, their own fanaticism and harsh policies having led to a general reversion. The great scholars such as the Imāms Mālīk and Ḥanbal vehemently opposed them and refused to believe that the *Qur'ān* was a creation. Ibn Ḥanbal not only emphasised and popularised the teachings of *Ḥadīth* and *Sīrah* but also opposed new innovations. Political considerations also persuaded al-Mutawakkil (846–61 A.D.) to change the policy of the state. Deprived of the royal protection the beliefs rapidly lost ground. However, the *coup de grace* was delivered not from outside but from within. Al-Ash'arī, a former Mu'atazilite, recanted from his beliefs and began to oppose them. He has been accepted as the main enemy of the Mu'tazilites to whose credit goes their ultimate end.

The victory of the Ash'arite doctrines greatly strengthened orthodox beliefs. In fact, a new and a third integration of the Islamic world had occurred. The uniformity of these Islamic beliefs and opposition to Greek knowledge, sciences and philosophy, appeared general. In this way a certain religious atmosphere became common and notwithstanding the political rifts and divisions, maintained the idea of the Muslim world's unity a fact and a reality. Muslims visiting distant countries of Islam found the environment congenial and felt themselves at home. This religious unity was quite strong. Islamic beliefs divided the world into two parts *dār al-Islām* (the Islamic territory) and *dār al-Ḥarab* (the regions of non-Muslims). Muslims living in Muslim countries knew that they

were living in *dār al-Islām* and felt no inhibitions in visiting them.

A new and important development was the popularity of the Shi'ite beliefs in the eastern and western regions of the Caliphate (the third and fourth century of Hijra). During the 8th century of the Christian era, the Shi'ite beliefs evolved into two clear groups, the Ithnā-ash'arites and the Ismā'ilīs. Both these groups believed in Imamate, *naṣ* and *tawīl*. The difference arose on succession to the line of *imāms* after Ja'far al-Sādiq (d. 145H./765 A.D.) contemporary of the 'Abbāsīd Caliph al-Manṣūr (754–75 A.D.).

The Ismā'ilīs believed that the imamte passed on to Ismā'īl, the eldest son of Ja'far al-Sādiq, as the seventh *imām* and were henceforth known as Ismā'ilīs and the believers in seven. The Shi'ahs hold that Ismā'īl was not given the succession's right but the imamte passed on to Mūsā al-Kāzim whose line continued upto Muḥammad al-Muntazar, designated as Mahdi. The idea of a redeemer (Mahdi) is common to various beliefs and, in fact, may generally be found in different religions and sects of mankind. The first definite reference to the concept of Mahdi occurs during the Caliphate of al-Manṣūr. This idea was close to the concept of incarnation of deities for redeeming this world, which was rife among the Buddhists and the Manichaeans. Subsequently the concepts of Mahdi and incarnation (*hulūl*) became closely identified. Political persecutions forced this movement to become secret. The 'Abbāsīd period saw this branch of Shi'ism developing regional and ethnic affiliations. It was able to gain Yemen and North Africa to its cause. At one stage coinciding with the decay of the 'Abbāsīds, the Ismā'ilī beliefs nearly overwhelmed the whole Muslim society. Their agent and *dā'īs* ranged all over the Muslim world. The 10th century witnessed the greatest period of glory for these beliefs under the Fātimids (909–1171 A.D.) with their new capital at Qāhira (Cairo founded in 969 A.D.). In the east their movement was characterised by two developments. In Iran and Transoxiana where the 'Abbāsīds had been successful, they adopted a rational and philosophical style while in Sind they closely identified the idea of redeemer with that of the awaited incarnation of Vishnu. The former gave birth to *Ikhwān al-Safā*, while the latter resulted in *Dasā-avtar*, one of the canons of modern Ismā'ilīs. The Ismā'ilīs seized power in Sind and

Multan.⁶¹ Their underground activities posed a serious threat to orthodox rulers. This threat and also orthodox reaction motivated Sultan Maḥmūd to attack Multan twice. It may be pointed out that Maḥmūd's attack on Anandpal (1006 A.D.) was mainly due to the latter's refusal to allow the Sultan to attack Multan across his dominions.⁶² At the same time Maḥmūd persecuted Ismā'īlī agents at home. One such man, called Tāhiraṭī, was arrested and executed on Maḥmūd's order.⁶³ In this way except for Sind and Multan the other regions in the east did not support Ismā'īlī beliefs but the *Ithnā Ash'arite*, e.g., the Buwayhids and the Ziyārīds. Thus when orthodoxy reigned supreme in Baghdad and philosophy and logic were exiled as innovations, the non-orthodox rulers, however, championed the latter's cause. The Buwayhids and the Ziyārīds greatly encouraged these studies. Their encouragement was responsible for the writing of the fifty two *Rasā'il of Ikhwān al-Safā*, out of whose five authors three are said to be Iranians.⁶⁴ It may be pointed out that Ibn Sīnā, the third and the last great *faylsūf* of the Muslim World, descended from Ismā'īlī parents and was often regarded as an Ismā'īlī. Another great Ismā'īlī was the Persian, Nāsir-i-Khusraw 'Alawī.

By the 10th and 11th centuries all the religious disputes and conflicts between the two major sects of Islam and between the rationalists and the orthodox had come into existence. The major schisms and groupings in Islam had occurred. These conflicts were sometimes bitter and led to persecution and bloodshed. The Mu'atazilite harshness was a point in this case. This is exemplified by the harsh treatment meted out to Imām Ibn Hanbal. These two sects also clashed. The bitterness became so strong that it was said that anyone trying to get martyrdom should enter *Dār al-Bittikhi* in Kufah and should ask God's mercy for 'Uthmān loudly.

Sometimes cities and regions were at loggerheads over religious disputes. Qum was noted for its excessive zeal for Shi'ism, while the people of Isfahan were Sunni. A number of places were ruined due to religious disturbances.

Religious sentiments were often exploited for political aims. The 'Abbāsids, the Fātimids, and the Buwayhids etc., used religic is feelings to establish their political power. The Buwayhids who

acquired power by championing Shi'ism were able to gain complete control over the 'Abbasid Caliphs of Baghdad. However, they never tried to replace them by 'Alid Caliphs for fear of undermining their own position.

Nevertheless, these disputes had some positive and beneficial results as well. Scholars and ulema sometimes disgusted with these quarrels and at times stimulated by them turned towards further studies. Integration among the orthodox crystallised and unity among the like-minded people became a rule than an exception. Notwithstanding this reaction the urge to learn, inherent in Islam, and search for truth continued to grow. But generally the orthodox reaction had set in. Aversion to new knowledge had begun. The intellectual and literary equilibrium was upset. As this process was still in its initial stage, there were still some opportunities for the genius to shine.

GROWTH OF LITERATURE AND LEARNING

The rise and spread of Islam was paralleled by an unprecedented upsurge of literary and educational activities. Prior to this the weight of feudal and imperialistic social structure had kept intellectual activity to the minimum and only as a preserve of the privileged few. The growth of Islam stimulated the intellectual process. It was the first religion to introduce a society where pursuit of knowledge was not only allowed but encouraged. It is significant that the first revelation started with the *iqrā* (read, recite) and referred to *qalam* (pen) and *'ilm* (knowledge) as the "bounties of God."⁶⁵ The *Qur'ān* asks the believers to observe, study and draw conclusions. The Prophet (peace be on him) prompted the Muslims to make all efforts to learn.⁶⁶ After the battle of Badr (624 A.D.) the non-Muslim prisoners of war who were literate and were unable to pay ransom money, were allowed to earn their freedom by teaching literacy to ten Muslim children each. The faith of Islam is based on the twin belief in Allāh and the Prophet. The Word of God serves not only as a code of life but its recitation brings solace and spiritual rewards. The Muslims had to study both the *Qur'ān* and the traditions and life of the Prophet (*ḥadīth*). The former gave birth

to such branches of knowledge *tajwīd*, linguistics, grammar, the study of classical poetry, commentaries of the holy text etc., while the latter was responsible for the *ḥadīth*, *sīrah*, *rijāl*, history etc. Later the application of Muslim laws to new situations required its interpretation. In this way *fiqh* (jurisprudence) was created. All these sciences were related to religion and were given the common designation of *manqūlāt*. At the same time study of the *Qur'ān*, and development of new sciences led to a gradual reform of the script and made Arabic a better vehicle for the expression of new ideas, terms and theories. It was partly responsible for the supremacy of Arabic over the Zartushti, Syriac and other languages.^{6 7}

In this way Islam gave a fillip to learning which did not remain confined to the non-secular learning only. Expansion of the Caliphate brought the Muslims into contact with the exotic learning of the Greeks, the Romans, the Iranian and the Indians. Religious discussions with the scholars of other religions who were well conversant with logic and philosophy compelled the Muslims to study them. The need to find the proper direction for *qiblah*, led to a study of measurements with the help of stars, sun, i.e., astronomy and geometry. The Greek learning and its traditional divisions were accepted and assimilated by the Muslims.

Royal encouragement plus a desire to excel the non-Muslims in knowledge also stimulated the Arabs to seek knowledge.

These factors helped the pristine Muslim desire and necessity for knowledge to develop into a craze and finally into an unquenchable thirst which took hold of the Muslim world from the Caliphs down to the ordinary people. Cultivation of learning, poetry, calligraphy, and the finer arts became the distinguishing marks of a civilised and cultured way of life.

Education became a part of Muslim life. *Maktabas* attached to mosques, to the houses of nobles or some *khānqāhs* made education popular and easily accessible. Specialised instructions were given in *madrasahs* established by individual scholars or run by the state. Thus knowledge became widely diffused.

Patronage of the rulers was also greatly responsible for this extensive diffusion of knowledge and in its development. It provided

for the maintenance of *maktabs* and *madrasahs*. In such a conducive environment the scholars were able to devote their full attention to study and research.

A noteworthy example was that of Abū Rayhān al-Bīrūnī who was provided with all the necessities of life by Mas'ūd, the successor of Maḥmūd of Ghaznah, and was thus able to devote all his time to study and the pursuit of knowledge.⁶⁸ In some cases expectations of handsome rewards were an incentive to scholars. Hunayn, the translator of Greek books received five hundred *dīnārs* as monthly salary and was often rewarded with gold equal to the weight of the translated book.⁶⁹ Al-Hakam II, the Umayyid Caliph of Cordova (961–76 A.D.), sent 10,000 *dīnārs* to Abū al-Farj for writing the *Kitāb al-Aghānī* and secured his autograph.⁷⁰ At the same time, the methodical translation of a large number of Greek and Indian books on such a large scale and labour would have been inconceivable without the munificence of the 'Abbāsīd Caliphs. Their fondness for the books of the ancients led one of them to request his Byzantine rival for all the books available in the latter's dominions.⁷¹

The break-up of the Caliphate into a number of smaller dynasties remained a political phenomenon only. The cultural and literary unity of the Muslim world remained unchanged. On the other hand the tradition of royal protection gathered more strength. These rulers with better regional incomes carried on the old tradition. No doubt Baghdad had served as a great centre of learning and translation but in the end its monopoly over the learned world began to strangle the spread of knowledge. The political disintegration broke this stranglehold and allowed a large number of men of letters and scholars to benefit from state support than was possible at Baghdad. These local rulers vied with each other in adorning their court with men of learning and ulema. Sometimes they engaged in battle of wits and literary dialogue to have the better of their opponents. Such a dialogue occurred between Sultan Maḥmūd and the Īlak Khān of Kashghar.⁷² The 'Abbāsīd Caliph was able to check Maḥmūd's threatened invasion by means of a literary riddle.⁷³ The desire to acquire the services of luminaries attained new heights with the Ghaznawids. Maḥmūd's craving for scholars earned for him the epithet of the 'kidnapper of scholars.'⁷⁴ Though it is based on mis-

understanding, the designation reflects Maḥmūd's love of the company of men of literature and science.

These scholars were greatly obliged to the royal patronage and were dependent on it. In that period a scholar or an artist could only prosper in his specialized field when he received recognition of his art and material support commensurate with his status and accomplishments. Such help and recognition could be possible at the royal courts only. Ziryāb, the famous scholar-musician and a disciple of Ibrāhīm Mūsālī, the court musician of Hārūn and Ma'mūn had to leave Baghdad owing to the animus displayed towards him by his envious teachers. He could find shelter and recognition at the rival Umayyid court of Cordova only.⁷⁵ Ibn Sīnā after leaving Kḥwārizm went to the courts of Rayy and Hamadan. In some cases these flights of the scholars from the wrath of angry patrons could lead to altercation.

A large number of these scholars were also in demand as ministers, secretaries, judges etc. From the days of the 'Abbāsīd Caliphs, the *wazīrs* were generally men of letters. These ministers in turn extended patronage to scholars. Besides the celebrated 'Abbāsīd *wazīrs* some noted *wazīrs* of petty dynasties may also be mentioned, such as Ismā'īl b. 'Abbād al-Sāhib (938–95 A.D.) belonging to the Buwayhid rulers Mu'īd al-Dawlah and Fakhr al-Dawlah, Aḥmad b. Hasan Maymandi minister of Maḥmūd of Ghaznah, Abū al-Hussayn Aḥmad b. Muḥammad al-Suhaylī of 'Abbās Ma'mūnid of Kḥwārizm. Ibn Sīnā also served as minister at the court of Hamadan. The services of Abū Rayḥān al-Bīrūnī were often sought as a companion and advisor at Jurjān and Kḥwārizm.

The ruler's patronage and inspiration often led to the inditing of a number of works such as *al-Mughnī fī al-Tibb* by Saib ibn Habut Allāh for Muqtadir, *al-Mansūrī* by al-Rāzī for al-Mansūr b. Ishāq, *Āthār al-Bāqiyah* and *Qānūn al-Mas'ūdī* for *Shams al-Ma'ālī* and Sultan Mas'ūd respectively.

However, there were independent scholars and schools generally upto the 9th century A.D. For example the five main Muslim schools of *fiqh* viz., Hanafī, Hanblī, Shafa'ī, Mālikī, and Ja'fariyah were established independent of royal patronage. In fact they were often in clash with royal policies. By the time of the 11th century A.D., a

change had come and scholars and men of letters were found attached to one or the other royal court. Learning and advanced research became so much dependent on royal support that al-Bīrūnī was constrained to admit that propagation of learning depends on royal patronage.⁷⁶

Libraries were indispensable. The rulers indulged in the hobby of collecting books and tried to have the best possible collection. Their example was followed by their nobles, chiefs and wealthy citizens. Individual scholars, *madrasahs* and mosques also possessed libraries of various size and standard. Though introduction of paper had considerably lowered the prices of books, they were all the same costly and rare. Nevertheless, the munificence of rulers made the existence of huge libraries possible. The library of Ḥakam II at Cordova consisted of 400,000 books whose catalogue was written in 24 quires of 20 leaves each. There were seventy other big libraries in that city. The library at Rayy where Ibn Sīnā studied for two years, day and night, was housed in a big mansion with books classified and stocked in separate rooms, shelves upon shelves, rows after rows on every subject. The library of al-'Azīz, the Fāṭimid Caliph (975-96 A.D.) contained several copies of the same book. These copies generally included an autograph of the author. Al-Ḥakam II of Cordova paid a handsome amount in advance to Abū al-Farj Isfahani for the autographed copy of *Kitāb al-Aghānī*. Al-'Azīz purchased a volume of *Tārīkh al-Ṭabarī* for one hundred *dīnārs*. By the tenth and eleventh centuries these libraries had become repositories of all the knowledge available at that time and it became possible for scholars to acquire knowledge without undergoing hardships for travel and search. Ibn Sīnā's studies at Rayy equipped him adequately for his life's work.⁷⁷ Similar libraries existed in all the big towns and cities.

The art of writing or calligraphy became an accomplished and a lucrative profession. Book-binding also became a specialised art. Book-shops abounded in cities. These shops were the haunts of men of letters. One such shop provided Ibn Sīnā with a guide-book of philosophy written by Abū Naṣr Fārābī. The book greatly facilitated Ibn Sīnā's understanding of the intricacies of that subject.

Another feature of the Muslim literary life was the existence of

a number of study circles. Such circles met after every Friday prayers. Maqdisi attended nearly one hundred and twenty such sittings in Jāmi' Masjid of Cairo. Such meetings also helped the itinerant scholars. The rulers and nobles also held such meetings. 'Alā' al-Dawlah held these meetings every Friday night. One of the *wazīrs* of the Buwayhids arranged daily sittings where every day one branch of learning e.g., *fiqh* was discussed. In Alexandria, there were daily gatherings devoted to the study of any one book of Galen before translating it into Arabic. Similarly the Christians of Baghdad had formed an *eskol* (school, from Greek *ekhole*). Sometimes dialogues in the form of written questions and answers between scholars helped in solving problems. The famous dialogues between al-Bīrūnī and ibn Sīnā and between al-Bīrūnī and the *pandits* of India and Kashmir are well known.

Travel was another form, and a highly esteemed way, of achieving knowledge. Though the tenth and eleventh centuries saw emergence of complete and up-to-date libraries, the utility of travelling remained. Ibn Khurdādhbah, al-Iṣṭakhrī, Ibn Ḥawqal, al-Idrīsī, Maqdisī etc., and the visit of al-Bīrūnī to Hind provided new material for knowledge and research.

The introduction of the paper industry gave an impetus to the spread of knowledge. The change came in 751 A.D. after the battle of Talās (also Tarāz) when the Chinese prisoners taught paper manufacturing to the Muslims. The 'Abbāsīd age saw complete change over to paper from papyrus and skin except where more durable documents were required.

In the same way important centres of learning had sprung up all over the Muslim world. In these centres, higher learning was imparted and new researches were carried out. Medina and Mecca were the earliest of such centres. The needs of religion and state initiated interest in religion, theology and law. Therefore, the two cities developed into seats of theological learning. By the tenth century a regular school of *fiqh* (jurisprudence), the Mālikī, grew up which became popular in Arabia, Africa and Spain.

A little later Kufah and Basrah, the two military cantonments founded in the reign of the second Caliph, became cosmopolitan cities having a large non-Arab population desirous of studying

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A little later Kufah and Basrah, the two military cantonments founded in the reign of the second Caliph, became cosmopolitan cities having a large non-Arab population desirous of studying

Arabic. Therefore, just as the study of Greek language by the non-Greeks of Alexandria had led to the development of Greek linguistics, the non-Arabs' use of Arabic gave birth to the study of Arab linguistics at Kufah and Basrah. It is interesting to note that the reform of Arabic script was initiated by Ḥajjāj bin Yūsuf, the governor of Basrah and Kufah. The expansion of the Caliphate raised problems of law. Ḥajjāj as governor of Kufah and Basrah was cognizant of these problems. For this reason, Kufah was the first Muslim city to evolve the earliest school of jurisprudence viz., the Ḥanafī, based on extension of interpretation of law by analogy and deduction. Thus the two cities developed into great centres of theology, *fiqh*, grammar and linguistics.

However, Basrah adopted rationalism. It became a cradle of moderate doctrines and knowledge on Islam. It gave birth together with Baghdad to the Mu'atizilite doctrines. Later when rationalism was retreating before orthodoxy the city brought into being Ikhwān al-Ṣafa (Brethren of Purity) and their celebrated treatises. Basrah's contacts with Iran enabled the movement to spread to Shiraz and Rayy onward.

However, besides the development of non-secular learning a start was made towards gaining knowledge from foreign nations as well. The Umayyids of Damascus under Mu'āwiyah and led by his grandson Khālīd encouraged Greek and Iranian knowledge. In this way Damascus may be said to be the first to encourage court poetry, history and other scientific pursuits.

The Arab desire to acquire new information became a craze under the 'Abbāsids. The new capital Baghdad became one of the greatest centres of learning in history. The 'Abbāsīd Caliphs encouraged translations of foreign works. For the first time wisdom of the East and the West met. Baghdad emerged as the first great centre of international intellectual activities. The confluence of knowledge of the Arabs, Persian, Muslims, Jews and Christians transformed pursuit of learning into a roaring torrent propelled onwards by the *Bayt al-Hikmah* which provided the much-needed organisation and direction to these efforts. Besides the literary circles and gatherings at the royal court, private literary circles were common such as *skhole* (also *eskol*) of the Christians of Baghdad. Prior to Baghdad, Alexandria,

Antioch, Hims, Hurran and Jundi Shapur were seats of Hellenistic culture and science. However, the theological studies were also not neglected. One noted school of *fiqh* was that of Sufyān Thūri.

The Greek learning acquired from former centres of Hellenistic culture gave birth to the rational reaction of the Mu'tazilites which started from Basrah and Baghdad. Later the al-Ash'arite reaction against the former also started from these very cities. As a result secular studies like philosophy etc., retreated to other places. This change coincided with the political downfall of the Caliphate and rise of regional dynasties. Cities such as Cordova in Spain and Cairo in the west became important centres. Bukhara, the Sāmānid capital and an ancient focal point of culture and learning re-emerged as a new centre of learning and also pioneered the revival or regeneration of the Persian language. Similarly, Shiraz, Rayy, Khwārizm became some new centres of learnings.

As stated earlier the secular studies started when the Muslims came into contact with the Hellenistic learning in Egypt, Syria and Iran. Acquaintance with the Indian sciences came later. The Arabs learnt little from Iran. It is said that they found little of interest in Iran in the form of new knowledge and learning. Iran under the Sassanids was permeated with Hellenistic culture. It drew heavily upon the craftsmanship and learning of the Syrians. Jundi Shapur, the celebrated medical centre of the Sassanid era was a settlement of the Syrian Christians. In the same way the Chinese had to offer little by way of new sciences except in technology and craftsmanship. The Arab saying succinctly sums up the whole situation: "philosophy descended on the heads of the Romans, languages on the Arabs, heart on the Persians and hands on the Chinese."^{7 8}

Knowledge was acquired by the Arabs through translations. Most of these translations were made by the Syrian Christians and Jews. Among them Hunayn b. Ishāq (809–73 A.D.) and Thābit ibn-Qurrah (836–90 A.D.) translated Hippocrates' books on medicines, Dioscorides work on botany, Plato's *Republic*, Aristotle's *Meteorologis* and many other works, real or apocryphal. Among the latter may be included the *Lapidary*, *Liber de elementis*, *Secreta Secratum*, *val liber de regimine primafux* (*Sirral-asrār* in Arabic) etc.

The seven volumes of Galen's anatomy are no longer extant except in its Arabic translation. Hunayn was a Nestorian and a Syrian. He translated not only Galen (he completed 95 Syrian versions - five of them twice and 39 Arabic versions of Galen's works) but he also translated the works of Hippocrates, Plato, Aristotle, Dioscorides, and Ptolemy's *Quadripartitum*. His teacher, Ibn Masawayh, was also a translator of several Greek medical works into Arabic and was, like him, a Christian. Hunayn himself had spent some time in the Byzantine dominions studying Greek.⁷⁹ Thābit ibn Qurrah who hailed from Harran translated the bulk of Greek mathematical and astronomical works of Archimedes, Euclid, Appolonios (Books 5-7) Theodosios, Ptolemy (geography), Galen, and Eutosios. His was a most original mind and he has been cited by Spengler as symbolizing the efflorescence of Muslim genius. The period of these translations continued upto the middle of the ninth century A.D.

It has been suggested that as the Arabs had limited access to the Greek languages, they were unable to detect the spurious works. Some of the great works remained unknown to the Arabs. The translators were handicapped by lack of new terms. The propensities of the age limited the Arabic choice of subjects and works. As late as the 11th century al-Bīrūnī acknowledged the difficulty of translating into or pronouncing foreign words in Arabic. He also, for example, accepts 'the *Lapidary*' as a work of Aristotle. Nevertheless, the translators conscientiously tried to do their best. The terms coined by Hunayn b. Ishāq were found suitable and continued to be employed. These translations were done after due deliberations. In Alexandria the books of Galen were thoroughly studied and discussed before translation was taken in hand. Hunayn was not very proficient in Arabic but he took help from his son Hubaysh ibn al-Ḥassan (or Al-A'sam, the one with a lame hand) who possessed good command over the Arabic language. However, the Arabs were not able to find all the books of the ancients. This situation was due less to any lack of effort on their part than to the difficulties of communication at that age. Nevertheless, their performance was creditable, and with the translations, the Arabs were able to initiate research and higher studies. They learnt logic, philosophy, metaphysics, geometry, medicine and astronomy from the Greeks. But

they never misappropriated the knowledge and works of others, passing it off as their own. Their aim was pursuit of truth and justice. Ibn al-Haytham's object was justice and not passion and as paradigms he takes Galen and Aristotle.⁸⁰ Al-Bayhaqī clearly states: "When you find a good speech of other person, do not ascribe it to yourself and gain profit from it..." Al-Kindī writing a book on primary philosophy, dedicated to al-Mu'tasim, said: "The best of industries in respect and highest in grade is the art of philosophy, the definition of which is to gain the knowledge of objects in their realities to the best of human effort, because the object of the philosopher is attainment of truth and in his action to attain truth..." At another place he says: "It is binding on us to live with the truth and to acquire wherever we get, although it is found with the nations living at distant places and alien nations; because there is nothing preferable to truth than searching for truth. Truth should not be degraded, and its announcer humiliated. Nobody with truth is degraded but on the contrary he is honoured."⁸¹ Al-Ghazālī invokes Divine assistance: "O Allāh! show the truth to us to be true and assist us to follow it, and show the falsehood to us to be false and assist us in avoiding it."⁸² In this way the Arabs avidly acquired Greek knowledge and learning. Greek learning became a specialised field of study and its experts were designated as *faylsūf* (philosophers).

Acquaintance with the Indian sciences was made a little later and in three stages. The first period belonged to the reign of al-Mansūr (754–75 A.D.) when Brahmagupta's *Brahma Siddhants* (*Sind Hind*) and *Khundakhadyaka* (*Arkand*) were translated. This new information in the fields of mathematics and astronomy provided fresh avenues of research. The second phase started with reign of Hārūn (786–808 A.D.) when besides astrology, works on medicine, pharmacology, toxicology and philosophy were translated. When Sind became independent probably after the rise of the Saffarids (867–902 A.D.) contact with Sind and Indian knowledge ceased. The next contribution was made by Abū Rayḥān al-Bīrūnī on his own initiative, though the opportunity was provided by the Ghaznawid involvement with Hind. This time translations were made by an Arabic-knowing scholar already well acquainted with the

current knowledge, and after learning Sanskrit, the literary language of India.

It may be pointed out that most of the knowledge of the Indian sciences was acquired by the Arabs from the regions of Western India, viz., Sind, Multan and Kashmir. Unfortunately none of the Muslim rulers developed any curiosity for Indian knowledge. Therefore, its acquisition remained secondary to the Greek learning.

The 4th century of *Hijra* (9th–10th centuries A.D.) marked the climax and the apogee of Muslim knowledge and learning which culminated in the 11th and 12th centuries A.D. The age of translations was over. Early bewilderment at the mass of new learning pouring from all directions had given way to systematic study, assimilation and further research. A firm and correct foundation for all the sciences was laid. An intense search for truth marked these efforts. Knowledge was not treated as the preserve of a selected few. It was accessible to all and was universal in the Muslim society transcending political, ethnic and physical barriers. By this time all the major theological and intellectual movements in Islam had fructified. Subsequent dissensions and controversies had emerged. These scholarly conflicts and clashes often spurred adversaries to greater intellectual efforts to surpass their rivals.

Two different and opposite tendencies may be discerned working side by side. The philosophical and scientific spirit starting from al-Kindī and al-Fārābī and *Ikhwān al-Safā* ended with Ibn Sīnā in the east. At the same time an orthodox revival in the reign of al-Mutawakkil (d. 847) and championed by Abū al-Hasan al-Ash‘arī (b. 873–4) was gathering momentum. It succeeded in super-imposing a uniform orthodoxy over a greater part of the Asiatic Muslim world, and the third and final integration of the Muslim world, materialised. However, although philosophy and rationalism were banished, during the last half of the 10th century and first half of the 11th century of the Christian era, rigid uniformity was not fully established. There was still some scope left for the study of philosophy and natural sciences. But continuance of such studies could invoke serious censure. An awareness of this danger may be found in the writings of al-Bīrūnī.⁸³ Notwithstanding, the desire

for new knowledge still inflamed the scientists and scholars.

Another characteristic of this period is the displacement of centres of learning, literature and culture from the *qalb* or centre of the Caliphate to the peripheral regions. As long as the work of translations and assimilation of foreign knowledge was going on the centralisation of scientific and literary activities at Baghdad proved beneficial. Under the vigilance of the Caliphs, the work became organised and systematic and its accomplishment was guaranteed by the immense resources of the Caliphate. But after this phase was completed, centralisation of the literary life became an impediment to further progress. A scholar who wanted to gain recognition had to go to Baghdad where the already entrenched ulema and scholars made the entry of any new rival very difficult. The point is well illustrated by the episode of Ziryāb, a disciple of Ishāq Mūsālī. Ziryāb had to leave Baghdad due to the envy of his teachers but his excellence made him readily welcome at Cordova. Thus even the well-established Mūsālī family could not tolerate the rise of one of their disciples, to say nothing of a new entrant. Failure to win recognition at these exclusive literary centres could have led to many broken hearts.

Political break-up of the Caliphate was followed by the dispersal and decentralisation of learning and knowledge. New centres in Spain, Egypt, Khurasan and Transoxiana arose. One lamp lit other lamps and thus literary and cultural contacts were kept up resulting in unity in diversity.

The fertile and prosperous eastern regions of the Caliphate, Khurasan and Transoxiana, were in a position to accord the patronage needed for the development and progress of learning. The geophysical situation had made Transoxiana practically the last horizon of the civilizations of the south, having limited contacts with China. Thus it became a cultural *cul-de-sac* which later developed into a frontier distributory of cultures of Muslim world in the 9th and 10th centuries. Such a distribution point was bound to affect the fertile soil, under suitable conditions and blossom into luxuriant growths of culture. Spain and Transoxiana had passed through a similar process of cultural evolution before the rise of Islam, e.g., the Hellenistic culture. Transoxiana, a centre of

different ethnical and cultural influences, viz., Iranian, Turanian, Indian, and to some extent Chinese thus witnessed an unprecedented flowering of Muslim genius.⁸⁴ This does not mean that the progress of learning works in an inverse ratio with political power. The 'Abbāsid Caliphate as an effective political power was gradually replaced by semi-independent and subsequently independent dynasties, all paying nominal allegiance to the Caliphs. There was no sudden collapse, but a gradual substitution of one by the other. Thus political and economic stability was in fact left undisturbed. The new strong dynasties ruling compact and smaller areas provided greater political and economic stability. At the same time the cultural and literary unity of the Muslim society was left unimpaired. These dynasties provided greater facilities for the development of cultural, literary, and scientific activities. In this way one could expect that the development of the Muslim society in economic, literary and scientific activities would continue. In other words, the fusion of Islam's indigenous learning with foreign knowledge was complete. The time of effervescence was arriving. The unprecedented and widespread development of the 10th and 11th centuries may be seen from the following list of scholars attached to various courts.

The Buwayhids

1. Abū Maḥmūd al-Khujandī d. 992 A.D. the inventor of the sextant.
2. Abu Sahl Al-Kūhī d. 990 A.D. mathematician and astronomer.
3. Abū al-Wafā al-Buzjānī 940–98 A.D.
4. Abū Naṣr Maṣṣūr d. before 1037 A.D.
5. Abū Sa'īd Aḥmad Sijistānī, a contemporary of al-Bīrūnī.
6. Abū al-Hasan Awkḥūr.
7. Aḥmad b. 'Abd Allāh Ḥabash (al-Ḥasib), the discoverer of the use of tangents, co-tangents and secants.
8. Abū 'Abd Allāh Al-Battānī 855–929 A.D. one of the world's major astronomers.
9. Sharīf b. al-'Ilm, d. 988 A.D.
10. Abū al-Ḥusayn 'Abd al-Raḥmān 903 A.D.

11. Abū 'Alī Maskawayh d. 1030 A.D.
12. Abū Naṣr Al-Fārābī d. 950 A.D.

The Fatimids of Egypt

The reigns of 'Aziz Allāh (975–96 A.D.)
and Ḥakam b. Amar Allāh (996–1021 A.D.)

13. 'Alī b. Yūnus d. 1009 A.D.
Al-Ḥaytham.

Baghdad

14. Ibn Sam'ūn
15. Kḥḥatib Baghdādī
16. 'Alī b. Amjūr
17. Abū al-Ḥassan 'Alī b. Amjūr

Spain

The reigns of 'Abd al-Raḥman III (912–61 A.D.), Ḥakam II
(961–76 A.D.), and Ḥājib al-Manṣūr (d. 1002 A.D.)

18. Al-Majritī d. 1007–8 A.D.
19. Jābar Aflaḥ d. 1038 A.D.
20. Al-Zurqānī (Saphaca) last years of 5th century of *Hijra*.
21. Sā'igh b. Bajjah (Avempace) d. 510 A.H.

In the above mentioned list may be added the names of Ibn Sīnā (Avicenna) and that galaxy of great scholars that gathered at Ghaznah. Such a great pageant of scholars and scientists was perhaps never seen in the world before. The great researches and contributions of these personalities were stupendous and still evoke wonder and awe.^{8 5}

A characteristic of this intellectual activity was a curious fact that in the period under discussion and even before, (8th–11th centuries), most of the Arab scholars were confined to the study of literature, history, jurisprudence or theological studies, while in the secular studies, except al-Kindī and al-Ḥaytham, all the scientists and

scholars were generally non-Arabs viz. Central Asians, Iranians, Turks, Jews or Nestorians.

In the 9th century, a number of scholars belonged to the region of Transoxiana such as 'Umar bin Fakh̄rī from Tabaristān, Darīr from Jurjān, Abū Mūsā ibn Sh̄akir and his sons, Abū Ma'shar from Khurasan and the more celebrated Al-Khwārizmi, Al-Farghānī and Al-Bukhārī from Transoxiana. This rich literary and scholarly background coupled with the works of these men of learning paved the way for the flowering of the local genius in the eleventh century when Ibn Sīnā and al-Bīrūnī led the vanguard.

A large number of their discoveries were plagiarised by scholars in Europe. In many aspects they were the original pioneers. Some idea of this intellectual plagiarism may be formed by the following list of scholars and their discoveries now attributed to the Europeans.

| <u>Name of the Discovery</u> | <u>Muslim Discoverer</u> | <u>European Discoverer</u> |
|----------------------------------|---|--------------------------------|
| Circulation of blood | Ibn al-Nafīs | William Harvey |
| Refraction of light | Ibn al-Haytham | Newton |
| Air and its weight | Al-Khāzin | Toricelli |
| Law of gravity | Al-Khāzin | Newton |
| Evolution | Ibn Miskawayh (Ikhwān al-Ṣafā) | Darwin |
| Principles of astronomy | Al-Battānī Al-Farghānī Al-Fazānī Al-Bīrūnī | Copernicus Galileo |
| Scientific method | Ibn Sīnā Al-Haytham Al-Bīrūnī | Bacon |

The first half of the 11th century may be described as the age of al-Bīrūnī.⁸⁶ Nevertheless a large number of scholars flourished in 10th and 11th centuries and made their mark felt in one or the other fields of study.⁸⁷ Interaction of these influences created a rather cosmopolitan outlook among the people who were ready to welcome new ideas. This may also explain the proclivity of the people of

Khurasan for revolutionary and heterodox doctrines which gave birth to many revolts during the 'Abbāsid rule. Transoxiana by its close proximity could not remain immune to the revolutionary ferment of Khurasan. This revolutionary ebullience was bound to invigorate intellectual thinking and demolish parochial rigidity. The objective and scientific curiosity of Ibn Sīnā and al-Bīrūnī may be traced back to this factor. Transoxiana had been not only a centre of literary and cultural activities long before Islam, but also of the Hellenistic culture which under the Kushans gave birth to famous Gandhara art of the north-west sub-continent. Bukhara was already a well-known centre of learning. At Balkh was situated the celebrated Nawbahār (*Nava-vihara*) Buddhist monastery. It is said that Zartušt was born in Soghdiana. The 'Abbāsid Caliphate owed its triumphant rise to power in a great measure, to Abū Muslim, a Khurāsānian.

The Sāmānid dynasty ushered in an era of stability and prosperity and at the same time patronised learning. Bukhara and other towns became new pivots of learning.

The Sāmānids were succeeded by the Fāwayhid̄s and the Ghaznawids who were celebrated for their encouragement to sciences and scholars. Indeed, the break-up of the Caliphate and rise of strong regional and national dynasties proved a blessing in disguise.

With the growth of literature and learning linguistic development was also going apace. In the beginning Arabic under the stimuli resulting from the expansion of Arabic culture and the emergence of new problems, was able to reform its script. Finally the Kufic script was replaced by *Naskh*. The possession of a superior script enabled Arabic to surpass and eliminate the defective scripts, e.g., the *Gabari* or Pahlavi script which was difficult to write and read. In addition as the official and the religious language, Arabic also became the *lingua franca* of the Muslim world from Spain to Sind. A bilingual era was ushered in the non-Arab regions which continued even when the population of these regions had embraced Islam and when the Caliphate declined in power. This diversity, no doubt, proved beneficial. But it also generated contradictory tendencies in the western and eastern areas of the Caliphate. In Syria and Iraq where the population had a Semitic or Arab origin, Islam became a national religion. Latin, Greek and the foreign languages

of the Christian Church were doomed. Syriac also fell into disuse as a language of pre-Islamic Christian days.

In Egypt and North Africa similar phenomenon was witnessed but as the local languages were mere tribal dialects, and none of them could compete with Arabic which gradually became the language of the whole region. However, in Iran, the Sassanid rule had established Pahlavi as the *lingua franca* of Iran. Being the language of the pagan past, it also lost ground. Its script was lost but it continued as the spoken language. Under the *Shā'ūbite* tendencies and the 'Abbāsīd movement, the Iranian language was able to do away with the stigma of paganism. Efforts were made to resuscitate it by purging it of the Arabic words. Ḥamzah ibn al-Ḥasan al-Isfahānī (961 A.D.) compiled annals in Arabic based upon Persian sources and displayed unmistakable *Shā'ūbite* tendencies. Some literary efforts were also made during the 'Abbāsīd rule. However, the Iranian language had in fact been able to acquire a distinction by grafting itself on the Arabic. It copiously borrowed words and literary forms from the latter.⁸⁸ Patronage to Persian poetry, the early form of its literature was given by the Sāmānids whose reign could boast of more than thirty poets including Rūdakī, acknowledged as the Chaucer of Persian. It is suggested that in the writings of Abū 'Alī Sīnā and Firdawsi, Persian language came of age. The former made conscious efforts to evolve Persian equivalents of Arabic terms and Firdawsi in his famous epic *Shāhnāmāh* employed as few Arabic words as possible. But Firdawsi's extensive use of Persian vocabulary could have been due to his desire to use Persian so as to convey a correct impression and give a naturalistic air to the story of ancient kings.⁸⁹ However, Arabic could not be done away with altogether. Even Ibn Sīnā wrote most of his works in Arabic. It was still the official language of Iran. Moreover, its extensive vocabulary, elasticity, and its ability to evolve new words to fit in with new meanings, especially the vast field of exact sciences, could not be denied. Controversy was certainly raging high in 10th century. Al-Bīrūnī deprecates this controversy and supports the use of Arabic as a language more suited to science.⁹⁰

CHAPTER II

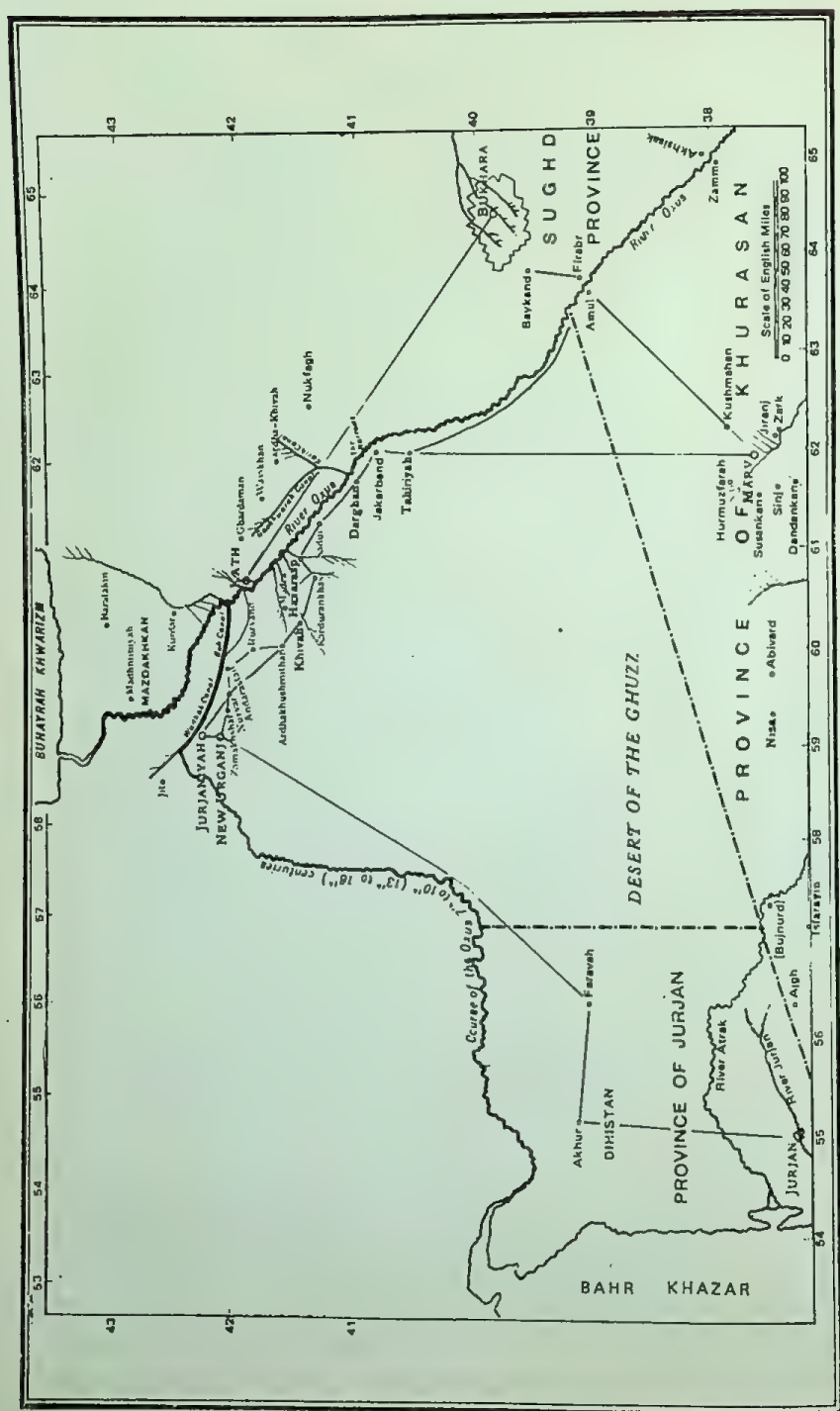
AL-BĪRŪNĪ AT KHWĀRIZM

PRE-GHAZNAWID PERIOD

When Aḥmad b. Muḥammad b. 'Irāq was ruling at Kāth during the last half of the tenth century A.D. and the region of Central Asia had attained a high degree of economic prosperity, literary growth, and cultural development, a boy called Muḥammad was born in a Persian speaking Tajik family in a suburban settlement in 362 A.H./973 A.D. as is testified by himself. In a letter written to one of his friends in 427 A.H./1035 A.D., al-Bīrūnī stated that he had completed sixty-three solar years which came to sixty-five lunar years.⁹¹ Tabrīzī provides more information that 'Imām Shaykh Ustādh al-Ra'īs Ḥakīm Burhān al-Ḥaq Abū al-Rayḥān Muḥammad bin Aḥmad al-Bīrūnī was born on the 3rd of *Dhu'l-haj* 362 A.H. i.e., 4 September 973 A.D. Al-Bīrūnī, although a Tajik by race, was Persian by culture. He, however, belongs to the fringe of the Persian culture. He is thus as Persian as the other great Persianised Turks like Nizāmī Ganjawi and Jalāl al-Dīn Rūmī were.

BIRTH-PLACE

A controversy has arisen about the birth-place of Abū Rayḥān. It revolves round the identification, interpretation and meaning of the word Bīrūnī, a part of Abū Rayḥān's name. Is Bīrūn a city? Where was it situated? Or is Bīrūn a suburb of Kāth or Kḥwārizm or does it merely denote one who was born or who lived outside the city of Kḥwārizm? This confusion had led some later authorities



to find some logical explanation behind this term. According to Sam'ani's *Kitāb al-Ansāb* the people of *Khwarizm* called the foreigners *bīrūnī* in Persian, and *al-bīzak* in the *Khwarizmian* dialects and for this reason the astronomer Abū Rayhān was called *al-Bīrūnī*. Ya'qūt in *Mu'jam al-Udabā'* (vol. xviii, p. 180) records a statement from a scholar who reasoned that *bīrūnī* meant an outsider and as Abū Rayhān lived only for a short period in *Khwarizm*, he was called *al-Bīrūnī*.⁹² Ya'qūt himself was not satisfied with this explanation and expressed his own opinion that perhaps it meant one who lived outside the city or in the countryside. Besides this *bīrūnī* or *bīrūn* are adjectives and are not used alone for denoting some particular group of persons or settlement.⁹³ Except Abū Rayhān no other person was given this appellation which means that it was not in general usage. Abū Rayhān's stay in *Khwarizm* was also not short for his first 23 years were spent in that region under the Āl-i-'Irāq and a further period of 8 to 10 years under the Ma'mūnids.

In all therefore he spent nearly thirty years in *Khwarizm* and was born in a suburb of *Kāth*, a town in the region of *Khwarizm*. His other contemporaries such as Abū Sahl Masīhī or Ibn Sīnā stayed for far shorter periods but none of them was ever styled *al-Bīrūnī*, although the latter was Persian in origin. The definitive use of *al-Bīrūnī* with the name of Abū Rayhān, therefore, appears to refer to his place of birth, a town or a suburban settlement. Keeping this interpretation in view some later authorities tried to trace this town or settlement. Unable to find any such locality or town in *Khwarizm* their search extended to other regions. A close resemblance between *Bīrūn* and *Nīrūn* suggested a possible explanation, accordingly to Shams al-Dīn Muḥammad Shāhrazūrī (1190–1214 A.D.) added this new information to his description of *al-Bīrūnī* in his book *Nuzhat al-Arwāḥ wa Rawdat al-Afrāḥ*. This misunderstanding was adopted by other chronicles as well e.g., Ibn Abī Asībāh (1203–70 A.D.) and Abū al-Fidā (1273–1331 A.D.) and was also accepted on these authorities by some modern scholars such as Reinaud.

Nīrūn was a town between Daibul and Maṣṣūrah in Sind and was probably situated near the site of modern Hyderabad.⁹⁴ In

that period the regions of Sind and Multan were under the control of the Ismā'īlīs or Carmathians who were opposed to the orthodox learning and it was nearly impossible for a Sindhi to acquire that fluency in Arabic as one finds in the writings of al-Bīrūnī. If for the sake of argument Nīrūn is accepted as the birth-place of Abū Rayḥān a number of other difficulties arise such as when and why did Abū Rayḥān leave Sind and reach Kāth where he remained up to the twenty-third year of his life. His remark that *Āl-i-'Irāq* strengthened his foundations implies a long association which argues against his early migration from Sind and acquisition of knowledge and accomplishment in various fields. Moreover, if he was Sindhi, Mahmūd Ghaznawī could not have considered it advisable to send him as a prisoner to the Punjab, so close to his homeland. Again, in his quest for knowledge about Sanskrit and the Indian sciences he met and corresponded with people from Multan to Kashmir only. He never referred to any Sindhi association and describes Indian society as viewed by a foreigner and not as a resident of India. His clear-cut statement that he visited the cities in the Punjab only further proves his foreign birth.⁹⁵ Besides, there are references that he was a Khwārizmian by birth.

In one instance Abū Rayḥān has been designated as Khwārizmī.⁹⁶ However, Abū Rayḥān was not born in the city of Khwārizm. He was born in Bīrūn, a suburb of the city of Kāth which was the capital of Gurgānj, one of the two kingdoms of the region of Khwārizm which was ruled by the 'Irāq princes. The city of Khwārizm, twenty *farsakh* away from Kāth, was the capital of the other kingdom of this region and was under the Ma'mūnid princes. Another probable explanation is that when Khwārizm became the capital of the united kingdom of the Ma'mūnids, the residents of Kāth who came to the new capital were designated as *bīrūnī* by the local residents of Khwārizm. As Abū Rayḥān was the most celebrated amongst them this designation became a part of his name. But as Khwārizm was also the name of the region he was also described as Khwārizmī.

FAMILY

A noted characteristic of Islam was the absence of any

hereditary class of scholars and religious people. Education which was devoted to cultivation of truth and knowledge, never became a means to acquire political power in Islam and, therefore, it was saved from being a privileged prerogative of any ruling class, viz., the Arabs. It remained accessible to non-Arab Muslims as well. In fact the non-Arabs excelled the Arab scholars. The scholars belonged to different strata of society and, therefore, it was difficult to trace their lineage or ethnic affiliations. The origins of some great scholars and 'ulema such as Imām Abū Hanīfah, the founder of the Hanafī school of jurisprudence or Abū 'Alī Sīnā remain disputed. However, in the case of Abū Rayhān it is an established fact that he belonged to Tajik stock. He did not belong to any of the affluent or well-known families of Kāth, for when a poet attacked his lineage and *nasab* calling him Abū Lahab and designated his mother as *Hammalat-al-Hatab*,⁹⁷ Abū Rayhān turned down the challenge and in a philosophic vein commented on the absurdity of these worldly considerations.

EDUCATION

Unfortunately, Abū Rayhān had not left any autobiographical account. There are some scanty references in his writings but they do not throw any light on his educational life. One may presume that he received the traditional *maktab* and *madrasah* education. He had referred to Abī Naṣr Maṣṣūr the 'Irāqī prince, as *ustādh* (teacher).⁹⁸ However, notwithstanding the fact that Abī Naṣr Maṣṣūr was a great scholar his status as a member of the royal house of Kāth (a cousin of the ruler himself) means that he could not have been a teacher in the traditional sense. Probably his residence was a meeting place for the luminaries and scholars of Kāth, al-Bīrūnī being one of them. It is in evidence that they had a mutual respect and high regard for each other. Such a benevolent patron was in a position to advance the material interests of his protegee, drawing acknowledgements of gratitude from the recipient. The assistance rendered by Abī Naṣr and his family made the life of al-Bīrūnī quite comfortable. He was cared for by them and his foundations in life were strengthened.⁹⁹

Later chronicles refer to one 'Abd al-Ṣamad as the teacher of al-Bīrūnī. It is said that when Maḥmūd of Ghaznah annexed Khwārizm the said 'Abd al-Ṣamad was condemned to death as a *bāṭinī* (Qarmat, Carmathian or Ismā'īlī) but Abū Rayḥān was spared for his skill in astrology (*nujūm*).¹⁰⁰ Earlier and contemporary authorities have not referred to any such teacher of Abū Rayḥān. Most of his education had been completed at an early date and it is not plausible to assume that he could have a teacher at the age of 44 years. Al-Bīrūnī was a great scholar and an encyclopaedist, always in search of new information. If there was any scholar such as 'Abd al-Ṣamad, he like other persons might have helped Abū Rayḥān in some way or other but not as his teacher. In any case although the episode of 'Abd al-Ṣamad may seem spurious, it throws an interesting light on the image of Abū Rayḥān held by later Muslims.

He was liberal and profoundly interested in sciences. In that age orthodox reaction had set in and Abū Rayḥān was himself wary of being accused of heresy while writing *al-Hind*. His other contemporary Ibn Sīnā, was regarded as a Carmathian (Qarmatī).¹⁰¹ Abū Rayḥān escaped the stigma of being called a Carmathian (Qarmatī); yet the people of that age probably considered him as a fellow-traveller of the heterodox doctrines and tolerant towards their devotees. The fact is that if Abū Rayḥān needed some information from a Carmathian he would have unhesitatingly availed himself of it freely, as in the case of Indian sciences.

He had also referred to one Muḥammad b. Ishāq b. Ustādh Bandād Sarakhsī. A misreading of the above mentioned name has led some scholars to regard Bandād Sarakhsī as one of the teachers of al-Bīrūnī. However, Abū Rayḥān was probably describing the *nasab* of Muḥammad b. Ishāq only and not referring to him as his own *ustādh*. The use of the term *ustādh* with Bandād Sarakhsī, the grandfather of Muḥammad b. Ishāq misled these scholars.¹⁰² With such sketchy and scattered information available it is therefore difficult to ascertain the factors or persons responsible for stimulating Abū Rayḥān's interest in the study of physical, natural and biological sciences. His access to the company of Abī Naṣr

Mansūr could be possible only because he was acceptable there as a scholar, however much of a neophyte he might have been. Probably the development of Khwārizm as a great centre of mathematical studies since the days of Mūsā b. Muḥammad al-Khwārizmī was to some extent responsible for it. Al-Khwārizmī by his translation of *Siddhanta* (Arabic, *Sind Hind*), his *Zij* (astronomical table) and *Jabr wa muqāblah*¹⁰³ made his homeland a great centre of these studies. The Khwārizmshāhīs of Kāth advanced his work further. They reformed the local *taqwīm*¹⁰⁴ and Abī Naṣr Mansūr discovered the use of tangents and co-tangents which greatly accelerated trigonometrical calculations.¹⁰⁵ In this way the academic atmosphere of Khwārizm was permeated with the study of mathematics. Abū Rayḥān born with a great analytical mind and keen comprehension was irresistibly drawn to these studies which ideally suited his temperament and capabilities. And, moreover, since his mind was endowed with both synthetic and analytical tendencies, perhaps mathematics came naturally to him. Travelling had been regarded as a part of education in Islam. But by the 11th century numerous rich libraries established by rulers, had greatly reduced the need to travel to distant places for acquiring knowledge. This was a period of turmoil and a seeker of knowledge could end on the gallows at the hands of religious fanatics. Abū Rayḥān like Ibn Sīnā¹⁰⁶ did not travel to distant regions for seeking knowledge. Both acquired all their knowledge in the cities of Transoxiana and north Iran where fate and political developments led them. However, when Abū Rayḥān wanted to study Indian sciences, he had to travel, visit, and use all the means at his disposal to have access to the scattered sources in western India.

The most noteworthy trait in Abū Rayḥān's character was his insatiable thirst for knowledge. It has been said that by the time when the great master was compiling his monumental work *al-Qānūn al-Mas'ūdī*, his knowledge about Indian science had ceased growing and showed some signs of staleness and confusion.¹⁰⁷ However, this lack of growth was not the result of any impairment of al-Bīrūnī's interest, but rather his inability to get further information from Indian sources, since he had to stay in Ghaznah

on account of his growing infirmity. His visits to north-west India therefore became sporadic and less frequent. At the same time most of the knowledge about India, available in western India (including Kashmir), has been acquired and absorbed, and al-Bīrūnī was not able to reach the other centres of Indian learning in the eastern and southern India, notably the latter. Another factor limiting the great scholar's search was the quasi-religious nature of Indian works which in some cases militate against Muslim beliefs¹⁰⁸ and al-Bīrūnī with all his liberal and eclectic approach could not consume such pseudo-scientific beliefs.

He was an indefatigable seeker of knowledge with no love for sensuous pursuits. With a single-mindedness, so rarely witnessed, he concentrated his efforts for the cause of truth. Abū Rayhān lived to a ripe old age with his intellect and wit sharpened and senses intact, to complete his projected goals.

His was a life of concentration and comprehensive study one day merging imperceptibly into the other, each day nibbling some fragment of knowledge, some item of interest which had to be meditated upon and worked out in the recesses of his creative mind. Except the two days when he permitted himself leave to procure supplies for himself, he worked all round the year. In the last year of his life the benevolence of Mas'ūd of Ghaznah further lessened his burden. His craze for knowledge made him open to the slightest suggestions. Once while studying Rāzī's works on *Ilāhiyāt*, the title of a book by Mānī the founder of Manichæism caught his attention. Forty years, he searched for the book before he obtained it.

Like a thirsty man he returned again and again to the fountain of knowledge. Even when his life was ebbing out he would not let the scarce minutes go by uselessly.

Very little is known about the family of al-Bīrūnī. Probably he had no children and this explains his polarised devotion throughout his life. Free from the burdens of parenthood he lavished almost paternal love on his studies and books.

Though it may be presumed that al-Bīrūnī acquired most of the Arabic and Greek knowledge extant in his age and studied the Greek books through Arabic translations, it is difficult to vouchsafe for his skill in the Greek language.¹⁰⁹ But probably

he was acquainted with Greek phonetic sounds and alphabets. Some idea of his linguistic proficiency could be gauged from his *Kitāb al-Ṣaydanah* in which, wherever possible, he gives the name of the herb or drug in Arabic, along with the Greek, Syriac, Persian, Sindhi, Sigzi, Zābli, Hindi, and also synonyms in other languages and dialects. The Roman synonyms given by him were of the language of the Byzantine Empire. Therefore, his knowledge of the Roman language should not be confused with Latin, the *lingua franca* of Western Europe. Among the sources he cites in order of frequency are Dioscorides, Paulus Aeginata, Ibn-Masāwaih, Abū Hanīfah, Hamzah, and a limited number of Greek and Latin pharmacographers, e.g., Galen, Qatājanīs (probably Cato the Censor), Atīwas (Actius) and Aristotle. The latter's apocryphal *Lapidary* is often mentioned by him while describing minerals and stones. His style is, however, similar to that of Dioscorides.

He had friendly contacts with Syriac and Christian intellectuals. One such friend was the famous physician Abū Sahl Masīhī. He was also on good terms with a Syrian Christian merchant from whom he learnt correct Greek names and pronunciation of medicines.¹¹⁰ He possessed a dictionary *chahār-nām* with equivalent words in Greek, Syriac, Arabic and Persian languages. An interesting evidence of his acquaintance with the Greek phonetics is provided by his comparison of Arabic and Greek phonetic sounds wherein he points out the defects of the Arabic alphabets in producing the correct pronunciations of foreign sounds.¹¹¹ In this comparative study al-Bīrūnī could have received help from some bilingual friends such as Abū Sahl. It might also be the product of some literary discussion. Therefore, apparently al-Bīrūnī at least possessed a minuscule knowledge about the Greek alphabets' sounds.

Sachau has compiled a list of the Greek works mentioned by the great sage in his writings.¹¹² However, as most of the books of the great master are lost such a list will remain incomplete. Al-Bīrūnī's reading was vast and cosmopolitan, even though reference in a certain book will be limited to the books of the topic under discussion and throw light on that particular aspect of his knowledge and exhaustive study of the subject matter. The celebrated dialogue between him and Ibn Sīnā¹¹³ conclusively

proved the level of scholarship attained by him to be better than that of his opponent. Ibn Sīnā was the acknowledged master of high rating. If al-Bīrūnī was able to get the best of such a gifted scholar, it was only by his superlative knowledge and alert intellect.

STUDY OF SANSKRIT

Abū Rayḥān was acquainted with the Arabic translations of Indian works. However, his researches had convinced him that the translations were defective for his purpose since they had been done by inept translators. Later transcriptional errors further complicated the problem and in some cases changed terms beyond recognition. One such instance was that of the Sanskrit word *Jiva* (Sines) which was changed to *jayb* in Arabic and later was confused with the Arabic word *jayb*.¹¹⁴ Such errors detected by al-Bīrūnī urged him to study the original Sanskrit works. When political developments brought him into contact with the Hindus of the sub-continent he made full use of the opportunity.

He learnt Sanskrit after attaining the age of 45 years. It has also been suggested that al-Bīrūnī could have learned Sanskrit and the west Punjab vernacular from the Hindus living in Ghaznah. But if it is accepted that al-Bīrūnī was sent directly to Hind from Khwārizm after a brief stop at Ghaznah then the above hypothesis will not be valid. Al-Bīrūnī's own version shows that he had a long period of study. In the beginning he was a student, but gradually he attained proficiency.¹¹⁵ He collected books and secured the services of Hindu scholars, neither sparing money nor effort. But he knew that his efforts resulted in limited success. He wanted more of wealth and freedom to acquire Hindu learning.¹¹⁶ It is also suggested that he used the services of Hindu¹¹⁷ pandits as the early orientalists in the sub-continent did. Al-Bīrūnī, however, does not appear to be a novice. He commanded a vocabulary of nearly 2,500 Sanskrit words.¹¹⁸ The facility with which he discusses and explains Indian beliefs and doctrines shows his full command over the subject. In this way it would be unfair to detract from al-Bīrūnī's greatness by painting him as a pseudo-Sanskrit scholar, though one may imagine the reluctance with which the

Brahmans would have agreed to impart their sacred learning to a *malichchha*.

He pronounced Sanskrit words according to what has been called spelling pronunciation. It is said that he was careless in transliterating the letters p, c, t, g and the aspirates *kh, gh, th, dh, ph, bh* and that he was unable to represent correctly the cerebral and retroflex sounds e.g., *r* and *d* and used Arabic dentals for them. However, these errors and slips could have been due to Kufic script and the pronunciation of this region. He tried to follow the sound of Indian pandits of the interior and ignored vulgar pronunciation of *gv* for *iu*. He attempted to give the proper and original sound of the sibilant *s* and the dental *s* in Sanskrit.¹¹⁹ He was able to mark the difference between the written and spoken language of the Hindus. He is also credited with the Sanskrit renderings of the Muslim legend on Maḥmūd's Indian coins, but this is doubtful. As he understood the real significance of Sanskrit terms he could not have described the Prophet (peace be upon him) as an *avtara*. In his works some errors may have crept in, in transcribing names.¹²⁰ But it would be too much to expect a hundred per cent correct rendering by a foreign scholar of the 11th century when such names have often been inaccurately understood even by modern authors.¹²¹

Better information now available tends to support al-Bīrūnī's versions of Sanskrit works. His studies, references and renderings serve as useful material for students of Sanskrit and Puranic studies. His proficiency in Sanskrit literature is also corroborated by the fact that he was able, while delving into the nature of God, to clearly explain the foundations of the Advaita school.¹²² He distinguishes between the beliefs of the educated Hindus and the common people.¹²³ He explains that they regard God as a Real Existence (*satyasya satyam*) and he is also able to explain arguments supporting this belief.¹²⁴ An idea of al-Bīrūnī's achievements in Indian studies may be formed from the number of books which he mentions in his works.

Before reaching Ghaznah, al-Bīrūnī's life was mostly spent in Khwārizm, Jurjān, and Rayy. As he was a resident of Kāth, he first came into contact with the Āl-i-'Irāq of Kāth, the ancient rulers of Khwārizm and received patronage from the reigning family.

It may be surmised therefore that this patronage probably started with the recognition of al-Bīrūnī's accomplishment during the twenty-three years spent in Kāth.¹²⁵ It may be presumed that like his other contemporary, Ibn Sīnā, he completed his education quite early. It seems that he remained associated with Āl-i-'Irāq for six to seven years. At the start of one's career, recognition of ability and encouragement at an early stage determines the flowering or withering of genius. Al-Bīrūnī's talent and intellect was nurtured by the Āl-i-'Irāq but out of them Abī Naṣr Maṣṣūr bin 'Alī bin 'Irāq Mawla Amīr al-Mu'minīn was mainly responsible for strengthening his foundations.¹²⁶ The tender care of Abī Naṣr Maṣṣūr and his family launched Abū Rayḥān al-Bīrūnī on to his academic career. However, the subsequent political upheavals destroyed his patron's family and forced him to leave Kāth. During these wanderings, he somehow reached the city of Rayy. It seems that al-Bīrūnī had to leave Kāth in a hurry and was unable to carry with him any money. Bereft of royal patronage, he encountered great hardships and lived in virtual penury. The bitter memory and despair of that dark period is reflected in the *Chronology*.¹²⁷ He found a striking parallel between his life at Rayy and the conditions depicted in the verses of Aḥmad b. Fārs.¹²⁸ Monetary difficulties did not daunt al-Bīrūnī, but any challenge to his intellectual supremacy could not be tolerated. Like other geniuses he was very confident of his great talent. But since he was not well off, the noted astronomers of Rayy paid scant attention to his genius and often insulted him. They even disputed his theories. This dispute could have been related to the shape of the earth and its rotation. Al-Bīrūnī was himself keenly interested in the earth's movement and its dimensions. Unable to verify calculations of al-Ma'mūn's period by direct measurements of an arch, he evolved out a trigonometrical method which he had tried to verify first in a level plain in North Dihistān in Jurjān and later at Nandana in India.¹²⁹

In the course of time, however, al-Bīrūnī's financial status improved, and this resulted in the acceptance of his personality and influence by the scholars of Rayy. Unfortunately, al-Bīrūnī did not mention the names of the scholars of Rayy. He had gone

to Rayy probably because it was one of the three great centres of astronomy (it was also the birth-place of Imām Ghazālī), the other two being Baghdad and Khwārizm. It is interesting to note that the three centres claimed the discovery of the sine theorem relative to spherical triangles. Al-Bīrūnī attributed it to his patron Abī Naṣr Maṣṣūr while Abū al-Wafā at Baghdad and al-Khujandī (a Turk by origin) at Rayy also claimed to have discovered it. At that time Fakhr al-Dawlah was ruling at Rayy (976–92 A.D.) under his patronage an observatory was established at Rayy where observations were carried out, and al-Khujandī invented the *sadas al-Fakhri* (Sextant). It appears that disciples of al-Khujandī (d. 992 A.D.) clashed with al-Bīrūnī on some problem pertaining to astronomy. The latter belonging to the Khwārizm school did not accept their contention which could have resulted in an altercation. Later, however, al-Bīrūnī appears to have won recognition for his learning.

Fakhr al-Dawlah, the ruler of Rayy, died in 997 A.D. He was succeeded by Majid al-Dawlah Abū Tālib Rustum (997–1029 A.D.). In 998 A.D. Shams al-Maʿālī regained his lost kingdom (Jurjān and Tabaristān) from the Buwayhids. Al-Bīrūnī, though gaining some recognition at Rayy was unable to receive any support from the reigning house. Hearing of the celebrated astronomer Shams al-Maʿālī invited him to Jurjān.¹³⁰ Al-Bīrūnī unable to withstand the cold reception at the Buwayhid court of Rayy, left for Jurjān whose ruler was a celebrated *inshā' pardāz*, a renowned calligraphist, and well-versed in the physical sciences. For nearly a decade al-Bīrūnī stayed with his new patron. It may be guessed that his stay at Rayy was between 995 to 998 A.D. (three years).

Al-Bīrūnī should have reached Jurjān in 998 A.D. for in 999 A.D., he completed his famous book *Āthār al-Bāqiyah* (Chronology) and dedicated it to his new patron. Al-Bīrūnī was a prolific writer and could have written the book in a year's time, a credit to his superior intellectual qualities and perseverance. For the three years' period since his departure from Kāth coincided with his stay at Rayy where he could hardly make both ends meet, or to carry on his literary pursuits. He also never made any reference to his writing that book before 999 A.D.

The dedication of the work to Shams al-Ma'ālī shows that al-Bīrūnī had profited much from his stay at Rayy. Later he was noted for his 'golden and silver tongue'. He knew and fully realised that patronage of rulers was inevitable for the pursuit of learning and research. Shams al-Ma'ālī was notorious for his harshness which in turn seems to be the result of his eighteen years in exile. The Zayārid chief was also a scholar and an author.¹³¹ He did not like flattery and praise but distributed awards on Nawrūz and Mihirjān through Abū al-Layth Ṭabarī.¹³² This attitude and his own scholarly achievements enabled him to appreciate the genius of al-Bīrūnī. The admiration of Shams al-Ma'ālī grew to such proportions that he is said to have asked the scientist-scholar to become his companion and to live in the royal residence.¹³³ Al-Bīrūnī acknowledged the bounty of his patron but hated him for his cruelty. Close proximity to such a cruel tyrant was bound to deter any one. Besides, tyrants were subject to whims and fancies.

Al-Bīrūnī dedicated another of his book *Risālah-i-Tajrīd al-Sha'at* to Shams al-Ma'ālī b. Qābūs. This Ibn Qābūs had the signal honour of having two books of the great scholar, dedicated to him. Besides, his ten-year stay in Jurjān gave al-Bīrūnī an opportunity to conduct the preliminary measurements of the earth's latitude.¹³⁴

However, al-Bīrūnī's close contacts with Qābūs augured ill for the great scientist. At that time an invitation for him came from the ruler of Khwārizm. Mystery shrouds the manner of al-Bīrūnī's departure from Jurjān. His public acceptance of another ruler's invitation could have unleashed the vengeance of Qābūs. Therefore, it may be presumed that al-Bīrūnī left Jurjān secretly. Probably yearning for his homeland and better prospects drew him again towards Khwārizm.

Abū 'Alī whose occupation of Kāth or Gurgānj had forced al-Bīrūnī to leave his home, was killed in 997 A.D. He was succeeded by his son Abū al-Ḥasan 'Alī who ruled upto 1009–10 A.D.¹³⁵ Al-Bīrūnī mentions him as one of his patrons. Abū al-Ḥasan delighted to surround himself with scholars. The noted scholar-statesman Abū al-Ḥusayn Aḥmad bin Muḥammad al-Suhaylī was his minister. He was instrumental in bringing Ibn Sīnā and

other scholars to Khwārizm. Al-Bīrūnī was therefore moving to a better and greater centre of learning. Khwārizm under the Ma'mūnids was more glorious than Jurjān, Rayy or Kāth.

The Ma'mūnid court of Khwārizm had become a successor to the literary heritage of the court of Bukhara whose Sāmānid dynasty was on the decline. Under Abū al-Ḥasan 'Alī and his brother 'Abbās, Khwārizm as a centre of learning again scaled new heights. It may be said that this period (997–1017 A.D.) marked the zenith of Khwārizm's literary glory. For this development, credit goes to Abū al-Ḥasan, who followed the old tradition of having noted scholars as ministers, appointed al-Suhaylī as his minister.¹³⁶ In fact, he was the scion of an illustrious house of Khwārizm and had been referred to as *wazīr ibn wazīr* (minister and the son of a minister). He was the author of the *Kitāb Rawdat al-Suhayliyah*. He asked al-Ḥakam bin Ḥārith to write the *Kitāb al-Suhaylī* on Shafa'ī and Ḥanafī *fiqh*. He introduced Ibn Sīnā to Abū al-Ḥasan and acquired for him a salary which was described as "amply sufficient" by Ibn Sīnā himself.¹³⁷ Al-Suhaylī was also responsible for bringing Abū al-Khayr Khummar to Khwārizm. These scholars acknowledged the help rendered by al-Suhaylī. Ibn Sīnā dedicated two of his books, viz. the *Kitāb Qiyām al-'Ard fī wast al-samā'*, and the *Kitāb al-Tabarak al-Anwā' Khata' al-Tadabbur Saba' Maqālat* in his name.¹³⁸ However, al-Bīrūnī neither referred to al-Suhaylī as his patron, nor dedicated any book to him. Apparently Abū al-Ḥasan 'Alī was himself responsible for bringing the noted scholar to Khwārizm.¹³⁹ Al-Suhaylī, however, could have suggested his name. It is difficult to assign any definite date to the arrival of al-Bīrūnī in Khwārizm. What is certain is that he reached there before the death of Abū al-Ḥasan 'Alī (1009–10 A.D.).

The Khwārizm court, thus, possessed an outstanding group of scholars. Abū Naṣr 'Irāq, who was erroneously identified with the erstwhile ruling dynasty of Kāth, excelled in mathematics; Abū al-Khayr Khummar in *ṭibb* (medicine); Abū Rayḥān al-Bīrūnī in astronomy; Ibn Sīnā and Abū Sahl Maṣīhī in Greek philosophy.¹⁴⁰

These scholars were facilitated to enjoy a care-free existence, indulging in highly academic dissertations, discussions and research. Such a gathering at Khwārizm and Ghaznah allowed only men of

exceptional calibre to shine and also catalysed the fusion of further efforts. Such an atmosphere made the genius of Abū Rayḥān al-Bīrūnī shine all the more brilliantly.

This grand galaxy was eclipsed by the brilliance of Ibn Sīnā and al-Bīrūnī. Rapport and complete understanding seemed to prevail except between the two great scholars, Abū al-Khayr Khummār and Abū Sahl Masīhī. Abū Naṣr 'Irāq acknowledged al-Bīrūnī's brilliance and wrote books in his name. But Ibn Sīnā did not write any such book. Probably the memory of the earlier clash still clouded their relations.

Abū al-Ḥasan 'Alī was succeeded by his younger brother Abū al-'Abbās who ruled upto 1017 A.D. He tried to maintain the policies inherited from his brother to the best of his efforts. However, relations between the new ruler and al-Suhaylī, the celebrated minister, deteriorated. Within three years the situation became intolerable for al-Suhaylī. The nature of their quarrel is not clear. But generally the deprecating attitude of ministers towards brother-successors and their arbitrary arrogation of power had often caused conflicts with rulers, leading to banishment or execution of the *wazīrs*. Al-Suhaylī fled from Khwārizm to Baghdad in 1013 A.D.¹⁴¹ Within four years after al-Suhaylī's departure Abū al-'Abbās was assassinated, and Maḥmūd Ghaznawī in retaliation of his brother-in-law's death attacked and annexed Khwārizm.

Maḥmūd's attack on Khwārizm has given rise to highly colourful accounts. It is suggested that Maḥmūd wanted to assemble all the learned scholars at his court. Having heard about the scholars of Khwārizm, he demanded from Abū al-'Abbās their transfer. Out of these scholars al-Bīrūnī, al-Khummār and Abū Naṣr 'Irāq attracted by Maḥmūd's liberality agreed to go while Abū Sahl Masīhī and Ibn Sīnā refused and with the connivance of Abū al-'Abbās, escaped. Maḥmūd hearing about Ibn Sīnā's escape attacked Khwārizm. He at the same time sent pictures of Ibn Sīnā drawn with the help of the image painted by Abū Naṣr 'Irāq to all cities with orders to capture the fugitive scholar.¹⁴² This highly colourful account has been accepted as genuine and Maḥmūd dubbed as "a kidnapper of literary men".¹⁴³

However, Maḥmūd's invasion of Khwārizm cannot be explained in such a romantic way. Maḥmūd's imperial nature could not have tolerated any smaller ruler independent of him. In fact Maḥmūd's demands for Khwārizm Shāh's acknowledgement of his suzerainty, and displeasure at the latter's secret alliance with the Khāns of Turkistan precipitated a crisis. The Khwārizmian army refused to accept the policy of accommodation and killed their ruler. Maḥmūd waiting for a *casus belli* attacked to avenge the death of Abū al-'Abbās, his brother-in-law.¹⁴⁴ Fortunately these details were supplied by an eye-witness and a man who himself was an actor in this tragic drama. He was none other than al-Bīrūnī himself whose account from his book *Masāmīr-i-Khwārizm* was quoted by Bayhaqī.¹⁴⁵

Ibn Sīnā and Masīhī left Khwārizm before Maḥmūd's attack. It is difficult to determine the exact date of their departure. They could have left earlier after the departure of al-Suhaylī in 1012 A.D. Al-Suhaylī's downfall coincides with the rise of al-Bīrūnī in the councils of Abū 'Abbās. He was responsible for advising him to develop friendly relations with the Turkish Khāns and the Īlak Khān. He appears to be the chief advisor of the Ma'mūnid ruler but was not designated as *wazīr*. In this way al-Bīrūnī due to his 'silver and golden tongue' was held in high esteem at Jurjān and Khwārizm wielding political influence as well, a position which he was never to hold again.

CHAPTER III

AL-BĪRŪNĪ AND YAMĪNĪ DYNASTY

THE GHAZNAWID PERIOD

RELATIONS WITH MAHMŪD

Mahmūd captured Khwārizm in 1017 A.D. Myth and romance shrouding the personality of the great conqueror have tinted all his doings, the Khwārizmian invasion being no exception. As usual with other apocryphal stories in history these stories, untraceable in contemporary chronicles, abound in later works. One such story (described in preceding chapter) mentioned by the author of *Chahār-Maqālah* attributes Mahmūd's invasion to his desire to possess the great masters viz., Ibn Sīnā, al-Bīrūnī, Ibn Khunmār, al-Masīhī and Abū Naṣr, and led modern scholars to brand Mahmūd as a 'kidnapper' of scholars.¹⁴⁶ It is said that out of these masters, al-Bīrūnī, Ibn Khunmār, and Abū Naṣr attracted by the celebrated generosity of Mahmūd agreed to go while Ibn Sīnā and al-Masīhī fled. The story would have remained unchallenged but for the first-hand information provided by al-Bīrūnī, himself in his *Masāmiri-Khwārizm* (non-extant). Fortunately, Bayhaqī made full use of al-Bīrūnī's version in his *Tārīkh-i-Yamīnī*. Al-Bīrūnī was one of the participants in the tragedy which unfolded itself in Khwārizm. Mahmūd was unhappy at the developing friendship between Abū al-'Abbās, the ruler of Khwārizm, and the Turkish Khāns (including the Īlak Khān of Kashghar). Mahmūd forced the issue by demanding that coins should be issued and *Khutbah* recited with his name. The nobles and army chiefs of Khwārizm refused to yield to

Mahmūd's demands and became rebellious. They were pacified with difficulty by al-Bīrūnī. Abū al-'Abbās caught between an angry Mahmūd and an insubordinate army, on the advice of al-Bīrūnī, tried to extricate himself by developing closer relations with the Īlak Khān and the Turkish Khāns of Central Asia, while at the same time trying to pacify his angry relative. However, the Khwārizmian ambassador Ya'qūb Jundī mismanaged the whole affair and by his malicious reports precipitated the crisis. Mahmūd demanded a personal or token allegiance. Abū al-'Abbās was probably not sure of his allies, the Turkish Khāns, and tried to placate Mahmūd. This infuriated his Turkish soldiers and led by Alaptgīn Bukhārī and Ahmad Taghān, they killed their ruler Mahmūd waiting for a *casus belli* attacked on the apparent plea of avenging his brother-in-law's murder.¹⁴⁷

Another important point in disproving the spurious anecdote of *Chahār Maqālah* is the fact that Ibn Sīnā had left Khwārizm a long time earlier. He met Qabus, ruler of Jurjania before his death, i.e. 1012–13 A.D.¹⁴⁸

Obviously *Masāmīr-i-Khwārizm* was written after 1017 A.D. and the details about al-Bīrūnī's active participation were known to nobody; otherwise Mahmūd could have treated him in the same way as he did Ya'qūb Jundī. Ya'qūb's epistle when discovered three years after Khwārizm's fall, so enraged Mahmūd that he had the former executed.

However, al-Bīrūnī escaped a fate similar to Jundī's probably because *Masāmīr-i-Khwārizm* came to light after Mahmūd's death and at a time when emotions about Khwārizm's fall had cooled off. Bayhaqī used the information contained in the 'Masāmīr' in the historical work *Tārīkh-i-Yamīnī* (1164 A.D.).

If the story of *Chahār Maqālah* is accepted as genuine, it fails to substantiate another fiction, the story about Mahmūd's imprisonment of al-Bīrūnī.

After the fall of Khwārizm nearly five thousand people were brought in captivity to Ghaznah. After some time most of them were released and the rest along with the Khwārizmian princes were sent to the sub-continent as a precaution.¹⁴⁹ Some of the modern scholars basing their surmise on the remarks of al-Bīrūnī

in his book the *Kitāb fī Tahqīq Ma'l-Hind min Ma'qūlah Maqbūlah fī'l-'Aqal wa Murdhūlah* (the *Kitāb al-Hind*) think that he was sent as a prisoner to India.¹⁵⁰ The remarks of al-Bīrūnī are: "I have found it very hard to work my way into the subject, although I have a great liking. I do not spare either trouble or money in collecting Sanskrit books from places where I supposed they were likely to be found. What scholar, however, has the same favourable opportunities of studying this subject as I have? That would be only the case with one of whom the grace of God accords, what it did accord to me, a perfectly free disposal of his own doings and goings, for it has never fallen to my lot in my own doings and goings to be perfectly independent, nor to be invested with sufficient power to dispose and to order as I thought best. However, I thank God for that which He has bestowed upon me, and which must be considered as sufficient for the purpose".

Out of this extract, the sentence "for it has never fallen to my lot in my own doings and goings to be perfectly independent", has been construed to mean that al-Bīrūnī did not enjoy complete freedom of movement in India as he was a political detainue. The contradiction of his visits to various places in the Punjab region while in detention was explained by presuming that he was a prisoner kept on honourable terms. Credibility is attempted to this theory by the reported mention of al-Bīrūnī's passage with military escort via Kabul to Ghaznah when on 15th September 1018 A.D. he contrived to determine Kabul's latitude.¹⁵¹

However, a close perusal of the available sources bring a number of new facts to light.

A study of the foregoing paragraph from *India* does not support Sachau's contention that it refers to the restrictions placed on al-Bīrūnī's movements. It is unfair to read one sentence without reference to its context. Referring to the difficulties of the subject, al-Bīrūnī referred to his efforts at obtaining books and information. His next two sentences acknowledged the favourable conditions he possessed. Still he yearned 'for a perfectly free disposal of his own doings and goings, for it has never fallen to my lot in my own doings and goings to be perfectly independent.' He did not refer to a free disposal or complete disposal of his doings

and goings but yearned to be perfectly in control of the affairs of his life, the ideal of a scholar who notwithstanding the favourable conditions attending his Indian studies refused to feel satisfied and wanted to be invested with sufficient powers to dispose and to order as he "thought best". A desire for 'perfect independence' and to do what he thought 'best' should not be overlooked. It may also be kept in mind that *India* was completed just after the death of Maḥmūd. Therefore, al-Bīrūnī had nothing to fear from the dead Sultan. Muḥammad, the younger son of Maḥmūd, was in power at Ghaznah. His power being threatened by his elder brother Mas'ūd, he was not in a position to encourage the scholars. Later in the reign of Mas'ūd reference to the dead Sultan's liberality was unwelcomed. Mas'ūd was angry with his father for nominating Muḥammad as the crown prince. It is reported that he revoked the rewards and awards bestowed by his father and for this reason people were angry with him.¹⁵² Al-Bīrūnī, a wise old man, could not let the political change affect his plans for further research and study.¹⁵³ He knew that art and science required the protection of kings: "For they alone could free the minds of scholars from the daily anxieties for the necessities of life, and stimulate their energies to earn more fame and favour, the yearning for which is the pith and marrow of human nature".¹⁵⁴ Al-Bīrūnī was rewarded in his efforts and Mas'ūd, himself interested in astronomy, provided the former with all the necessities of life thereby enabling him to devote all the energies and attention to study and research.¹⁵⁵

Modern scholars, though rejecting the anecdotes of *Chahār Maqālah* and *Nigāristān*, were unable to shake off the aura of romanticism around them. Sachau, though describing al-Bīrūnī as a cautious politician awaiting the issue of the contest between Maḥmūd and Mas'ūd, finds no connection between al-Bīrūnī's so called studied "neglect" of Maḥmūd in *al-Hind (India)* and the way in which he hastened to dedicate his main work on astronomy to Mas'ūd, who lost a major position of his patrimony.¹⁵⁶ Sachau's judgement remained one-sided as he was unable to tap other sources of information. In his ode on Abū al-Fath Busti, al-Bīrūnī clearly acknowledged the benevolence of Maḥmūd. The

The verses referring to Maḥmūd are:

ولم ينقبض محمود عني بنعمة فاغنى واقتنى مغضيا عن مكاسيا

"Maḥmūd did not grudge me any good things of life, he made me rich and bypassed my harsh demands".

عفا عن جهالاتي وابدى تكروما وطرى بجاه رونقى ولباسيا

"He pardoned my ignorance and began to appreciate me, and his appreciation refreshed my looks and dress".

The death of the appreciative Maḥmūd and the consequent uncertainty prevailing was clearly reflected in his ode where after describing the death of his patrons including Maḥmūd he wails:

عفاء على دنياي بعد فراقهم وواحزنى ان لم از قبل آسيا

"After them my world was destroyed, alas! I would not see them before my departure".

دخلقت في غزنين لحما كمضغة على وضع للطير للعلم فاليا

"I am left as a piece of flesh for those who have forgotten *ilm* and (I am) like the flesh left on the mat for birds".

فابتدأت اقواما وليسوا كمثلهم معاذ الله ان يكونوا سواليا

"Instead of them (the past people) nations who are unequal to them have been left, nevertheless, God unwilling, these nations (people) too are not lowly".

These verses reflect the bereaved mood engulfing al-Bīrūnī following Maḥmūd's death.

Referring to Maḥmūd in the *India*, al-Bīrūnī mentioned him sometimes as Amīr Maḥmūd and invoked God's mercy on him

(Vols. I, p. 116, II, pp. 13, 103). He also referred to him as *Yamīn al-Dawlah* Maḥmūd, may God's mercy be with him (Vol. I, p. 22). A more fulsome reference occurs in Vol. II, p. 2, 'The strongest of the pillars (of Islam), the pattern of a Sultan, Maḥmūd, the lion of the world and the rarity of the age, may God's mercy be with him'. The last reference does not reflect the studies character of neglect. He also referred to Mas'ūd merely as Sultan Mas'ūd in the introduction to *Qānūn al-Mas'ūdī*, and contrariwise indulged in glowing praises at other places. But it does not mean that at one place he neglected Mas'ūd while at the other he praised him. While referring to Mas'ūd in the *Qānūn*, al-Bīrūnī, referred to Maḥmūd as *Yamīn al-Dawlah* Maḥmūd *Aṭāl Allāh Baqā w' 'adam ali al-Ma'ālī wa-Ma'āthir Artaqā'ah*.¹⁵⁸ Besides, *Chronology* and the *Qānūn al-Mas'ūdī* were both written and dedicated to two different rulers while the *India* was written on the suggestion of Ustād Abū Sahl 'Abd al-Mun'im bin Nūḥ al-Tiflisī, and, therefore, it makes passing reference to Maḥmūd. It is unfair to compare its references to Maḥmūd, to the references of Qābūs in the *Chronology* or to those of Mas'ūd in the *Qānūn al-Mas'ūdī*.

Similarly al-Bīrūnī's reference to Maḥmūd's attacks on India has been misinterpreted. He said: "He utterly ruined the prosperity of the country (of India) and performed those wonderful exploits by which the Hindus became like atoms of dust scattered in all directions, and like a tale of old in the mouth of the people". The remark has been taken as a stricture and criticism against Maḥmūd and the passage about the ruining of the prosperity of the country was regarded "as perfectly out of place in the glorification of a Ghāzī like Maḥmūd". But the second half of the sentence, 'those wonderful exploits by which the Hindus became like atoms of dust scattered in all directions', glorifies Maḥmūd's exploits in a typical orthodox vein. In fact here also, as in the case of al-Bīrūnī's reference to his studies in the sub-continent only a portion of the sentence or a sentence out of the whole paragraph has been taken out and made the basis of an argument against Maḥmūd.¹⁵⁹

It is also improper to judge al-Bīrūnī's praises on the standard of other eastern writers, for the great Khwārizmian scholar has

been accepted as a lover of truth. He acknowledged the protection of Qābūs and Mas'ūd for they treated him on a far superior level than other scholars. Qābūs offered him a direct participation in state affairs while Mas'ūd enabled him to devote all his time to his studies by making him free from all economic anxieties or government duties, a privileged treatment which was reserved only for a truly great sage. Al-Bīrūnī was thankful for such attentions and regarded it a duty to acknowledge such obligation.¹⁶⁰ However, he did not enjoy such a pre-eminent position in the court of Maḥmūd. He was one of the many luminaries in the great Sultan's court. He did not receive any special or privileged treatment and therefore did not mention it.

Besides this there were a number of other ways in which al-Bīrūnī paid homage to Maḥmūd's memory. In his instruments he repeatedly refers to the Yamīnī ring which was apparently named after *Yamīn al-Dawlah* Maḥmūd. Unfortunately, his history of the reigns of Subuktgin and Maḥmūd is lost which could have had cleared this confusion.

In the end the reference in the *Kitāb fī Tahdīd Nihāyat al-Amākin wa Tashīḥ Musāfat al-Masākin* that al-Bīrūnī while journeying with a military escort on his way to Ghaznah passed by Kabul. He wanted to determine the latitude of that city but his distress, "surpassing even the misfortune of Nūḥ and Lūṭ" stood in his way. However, he contrived to have some improvised instruments and took the measurements on Tuesday, the 1st of *Jamādī-al-Awwal* 409 H. (15th September 1018 A.D.). Towards the end of the same year in the month of *Dhu'al-Qadah* he observed a solar eclipse at Lamghān before reaching the capital. He met Maḥmūd somewhere on the way, while the latter was returning from his famous expedition to Mathura and Qannauj. It is said that Maḥmūd showed him the famous precious stone (weight 450 *mithqāl*) taken from a temple in Mathura. Al-Bīrūnī was not impressed by the quality of the stone (he was an expert on precious stones and later wrote the best book on precious stones in Muslim literature, i.e., the *Kitāb al-Jamāhir*). Maḥmūd sensing al-Bīrūnī's reaction withdraw the stone from the latter's view lest the popular notions about its value might be influenced. However, it stands

to reason that only the remarkable versatility of al-Bīrūnī, his genius, and his reputation could have influenced Maḥmūd to give him an audience and display the famous souvenir to him.¹⁶¹

These details conflict with some other information available to us. The exact mention of the day, and the date (month and year) leaves little doubt about al-Bīrūnī's presence in the vicinity of Kabul on the 15th September 1018 A.D. But it appears incorrect that he met Maḥmūd who was returning from his expedition of Qannauj, for Maḥmūd started on this expedition from Ghaznah on 13 *Jamādī* I, 409 A.D., while on 15th September al-Bīrūnī was at Kabul. Again it is not clear whence al-Bīrūnī was being taken to Ghaznah. Some scholars have assumed that he was being brought up from the fort of Nandana.¹⁶² A tentative hypothesis about al-Bīrūnī's detention at Nandana has now assumed the form of a positive assertion. It is stated that the escort leading al-Bīrūnī reached Ghaznah towards the end of the year. If one takes the *Hijra* calendar into account, the period from *Jamādī* I to *Dhū* 'al-Qadah comes to seven months and according to the Christian calendar the end of the year comes after 3 months. When journey from Kabul to Ghaznah occupied such a long period, the journey between Nandana (in the Salt Range area)¹⁶³ could have at least consumed two to three months. Bayhaqī has stated that after the fall of Khwārizm the prisoners were brought to Ghaznah. Thus if al-Bīrūnī was sent to Nandana, it could be from Ghaznah and not from Khwārizm. The journey from Khwārizm to Ghaznah and thence after a short stay, to Nandana could have easily taken six months time. The conquest of Khwārizm was complete by July 1017 A.D. On the 15th September 1018 A.D. al-Bīrūnī was at Kabul. The total period between these two dates comes to thirteen and a half months. If the period of journey, and in case of 5,000 prisoners rather a slow journey, from Khwārizm to Ghaznah being a difficult terrain, thence to Nandana and from Nandana back to Ghaznah — is taken into account, it leaves little time for al-Bīrūnī's sojourn in India for a period long enough to learn Sanskrit and the Indian sciences and to take the measurements of the towns of the Punjab; or to journey from Nandana to distant places such as Multan which was two hundred miles away.¹⁶⁴

It cannot also be said that al-Bīrūnī was being sent from Kabul towards Nandana, rather the evidence clearly points to a journey from Kabul to Ghaznah. It seems that Maḥmūd, having ordered the transfer of the prisoners of war from Khwārizm to Ghaznah, himself came to the capital. The military escort carrying the 5,000 prisoners marching slowly could reach Ghaznah either via Kabul or Qandahār. But the route from Herat to Kabul is shorter,¹⁶⁵ and could have been favoured. The Sultan meanwhile started for Qannauj on 27 September 1018 A.D. He might have met the prisoners coming from Kabul somewhere between Ghaznah and Kabul. As he was planning to cross the plains of the Punjab along the sub-Himalayan hills he marched towards Kabul on his way to the Khyber Pass. For if people wanted to go to Sindh they started from Sīstān and whilst marching to Hind or India proper they started from the side of Kabul.¹⁶⁶

However, this date given in the *Kitāb al-Tahdīd* clashes with some remarks in the *Qānūn al-Mas'ūdī*. According to these remarks (2nd chapter of the sixth treatise on the verifications of the longitudes of Ghaznah and Iskandriya) he took two measurements by means of the 'Yamīnī ring' in each of the years 409 and 410 A.H. (20 May 1018 A.D. to 8 May 1019 A.D. and 9 March to 26 April 1020 A.D.).¹⁶⁷ On 1st Jamādī I 409 A.H., 15 September 1018 A.D. al-Bīrūnī was at Kabul. Near the end of year probably in *Dhu' al-Qadah* or *Dhu' al-Haj* he reached Ghaznah. Maḥmūd was already on his way to India. How could al-Bīrūnī have secured permission to erect an observatory and have his measurements, and name the ring after *Yamīn al-Dawlah Amīn al-Mūllah Maḥmūd*? If for the sake of argument it is accepted that probably Maḥmūd received al-Bīrūnī in audience on his way to India and pardoned him, the problem still remains unsolved. Such an important occurrence would have been reported in the *Kitāb al-Tahdīd* whose compilation and drafting ended in 1025 A.D. A detailed study of the books of al-Bīrūnī may resolve the problems of these dates.

If al-Bīrūnī was sent as a captive to India where he was detained, one opinion is that he was, most probably, kept in the fort of Nandana.¹⁶⁸ No cogent reason has been put forward for suggesting

Nandana as the site of al-Bīrūnī's imprisonment. Perhaps his experiment in geodesy, i.e., measurement of the radius of the earth by his trigonometrical methods, suggested the site. The following are the names of Afghanistan and the sub-continent whose latitudes were measured by al-Bīrūnī himself: (1) Ghaznah, (2) Kabul, (3) Kandi Rabāt al-Amīr, (4) Dubnūr, (5) Lamghān, (6) Purshāwar (Peshawar), (7) Vaihind, (8) Jhelum, (9) Nandana, (10) Sialkot, (11) Mandakhakar, (12) Multan and (13) Lahore.¹⁶⁹ The list shows the latitudes of these cities arranged according to their distance and direction from Ghaznah and do not give the slightest indication where al-Bīrūnī was kept. The same author has acknowledged that al-Bīrūnī referred to Multan more than any other city and it seemed that probably he stayed there for quite a long time.¹⁷⁰ He had also mentioned Durlabh, a scholar of Multan, whose measurements he had copied and also used a page of *Zij* written by the latter. Nevertheless, Maḥmūd could not keep his political prisoners in a city which had been the centre of Ismā'īlīs, who were irreconcilable to the rule of a *Sunni* Sultan.¹⁷¹ If the measurements made by al-Bīrūnī himself are taken to show the places where he was kept as prisoner, the list would include places in Afghanistan and eight towns in the Punjab while they were situated at hundreds of miles away from each other, e.g., the distance between Nandana and Multan was two hundred miles.¹⁷²

A number of other problems also arise. If al-Bīrūnī was kept as a detainee in India, how, and when, did he get his reprieve from the Sultan. As subsequent discussion will show the great master did not spare any effort or money to collect books and information about Indian sciences. A prisoner, however honoured, could not be expected to have large sums for procuring these books and information from unwilling persons.¹⁷³

Al-Bīrūnī could have been one of the captives brought from Khwārizm and together with Ibn Khummār and Abū Naṣr might have been taken into service on reaching the capital. Al-Bīrūnī was too great an astronomer to be ignored by Maḥmūd, though at that time orthodox reaction had begun to brand such knowledge as heretic. Thus al-Bīrūnī wrote the *Kitāb al-Taḥdīd* to refute these allegations. It may be presumed that this book could have led to

the establishment of al-Bīrūnī's position at Maḥmūd's court. It is possible that Maḥmūd while passing the captives on his way to Qannauj gave him an audience. In fact, Maḥmūd went out of his way and showed the precious stone which he had brought from Mathura to the captive, al-Bīrūnī. Al-Bīrūnī may have been set free during the course of this audience. Such a premise explains his presence in Ghaznah and the taking of measurements. These measurements were taken with the help of the 'Yamīnī ring'. This could have been the former 'Shāhī ring' renamed and used by al-Bīrūnī earlier, or could have been its improved version.¹⁷⁴ After some time and shortly after his arrival al-Bīrūnī was able to have an observatory at Ghaznah¹⁷⁵ (in 1019–20 A.D.), where he took measurements with the help of the Yamīnī ring. After making Ghaznah as the focal point of his calculations he finalised and co-ordinated his astronomical and geometrical researches.¹⁷⁶ The Sultan could have valued him as an astrologer but at the same time he recognised his astronomical accomplishments. When a Turk hailing from the northward regions described the revolving of the sun on the North Pole, the Sultan's first reaction was to brand the man as a heretic. Abū Naṣr Maṣḥkān pointed out the artlessness of the Turk and quoted a verse of the *Qur'ān* with the argument that such things could be true. Maḥmūd asked for a verification from al-Bīrūnī who explained it to the satisfaction of the Sultan.¹⁷⁷ He was sometimes entrusted with the delicate task of interviewing foreign embassies such as that of *Qirā Khitā* which came to Ghaznah in 1026 A.D.¹⁷⁸ There are reasons to believe that he also interviewed the Bulghār (Volgan) embassy, earlier, in 1024 A.D.¹⁷⁹

Such diplomatic liaison could be given only to a man of 'silver tongue' and great wisdom. These facts conclusively prove that Maḥmūd did not neglect the great genius. But he was one of the many luminous stars among the luminaries gathered at the imperial court and could not receive that privileged treatment which he received under Qābūs or later under Maṣ'ūd. The two embassies supplied al-Bīrūnī with correct information about the regions of the Far East and Europe, a fact seen all the more clearly in the *Kitāb al-Saydanah* which was indited towards the ebb-time of his life.

Though some of the modern scholars do not credit him with

the discriminating quality of appreciating the learning and achievements of his court scholars. But he was credited with the authorship of a standard book on *fiqh* called *Tafrīd al-Furū'* and was regarded as a poet of repute. He was a great patron of learning and in this respect spent 400,000 *dīnārs* annually. He was remembered as a giver of *pīlwār* (elephant-loads) of silver.¹⁸⁰ But his qualities were coloured by a staunch orthodox belief.

Mahmūd was neither angry with al-Bīrūnī nor did he kidnap him and his colleagues. Al-Bīrūnī was probably brought as a prisoner from Khwārizm in 1018 A.D. He reached Ghaznah and was soon established there and built his observatory and dedicated one of his instruments to Mahmūd, viz., the 'Yamīnī ring'. These factors and the references in the ode to Busti clearly disprove the hypothesis based on mere supposition that al-Bīrūnī was not happy with Mahmūd and that he was kept as a prisoner in India. On the contrary one finds him living in Ghaznah upto September 1020 A.D. and again in 1024 A.D. However, the tradition of Mahmūd's imprisonment of al-Bīrūnī which was reported by *Chahār-Maqālah* could either be pure fiction or simply an anecdote demonstrating the whimsical nature of monarchs. Nevertheless, if al-Bīrūnī was imprisoned, he could have been imprisoned in 1017 A.D., when he had his first contacts with the Sultan. This episode if true could have happened at Khwārizm or Balkh. But as stated earlier on the face of it the story seems spurious and apocryphal.

Another supposition is that Mahmūd's relations with al-Bīrūnī were adversely affected by the harmful influence of Mahmūd's minister Ahmad Hasan Maymandī. It has been suggested that as al-Bīrūnī was the political advisor of Khwārizm Shāh, therefore, he was a rival of Ahmad Hasan Maymandī, the minister and advisor of Mahmūd. Attempt has also been made to attribute the change in al-Bīrūnī's conditions in the reign of Mas'ūd due to the fall of Maymandī from power. However, in the reign of Mahmūd also, Maymandī was under cloud and away from the ministry since 1025 A.D. He was recalled by Mas'ūd but died in 1033 A.D. He is wrongly portrayed as a political antagonist of al-Bīrūnī, for no such animosity is found in the writings of al-Bīrūnī.

or mentioned in any other chronicle. On the other hand, anecdotes were quoted to show how Maymandī procured the release of al-Bīrūnī from captivity.¹⁸¹ As stated earlier, lack of contemporary records and prejudice against Maḥmūd led scholars to theorise and thus the truth is lost somewhere in a maze of speculations.

Therefore, with the evidence enunciated above it is difficult to subscribe to the view that al-Bīrūnī was sent as a prisoner to India. However, the hypothesis of his detention in India easily explained his mastery over Sanskrit and Indian sciences by suggesting a forced prolonged stay. Al-Bīrūnī did visit India and stay there for some time. But there is evidence suggesting his acquisition of familiarity with Sanskrit at Ghaznah and his visits to the sub-continent on several occasions. The dates of his stay and supposed visit or visits can be determined by a study of the dates when he stayed or was reported in Ghaznah. This will also help us to determine the other assumption that al-Bīrūnī accompanied Maḥmūd on his expeditions to India which helped him in his Indian studies.

SCIENTIFIC AND RESEARCH WORK. (GHAZNAH)

He reached Ghaznah in 1018 A.D. During the next two years we find him conducting experiments and measuring the latitude of Ghaznah (1019 and 1020 A.D.). Two treatises on mathematics, viz. *Istikhrāj al-Awtar* and *Ifrād al-Miqāl* were written by him in 1022 A.D.¹⁸²

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Only three periods from 1018 to 1030 A.D. remain unaccounted for in al-Bīrūnī's life and during which his presence was not reported in Ghaznah viz., 1020–21, 1023–24 and 1028–29

A.D. These could be the periods when al-Bīrūnī¹, 27th September could have allayed Mahmūd's suspicions about his k¹⁹ A.D. the first two years of his stay at Ghaznah (1018–20 A. could not leave Ghaznah without Mahmūd's permission. Such could be construed as contumacious on the part of a Khwār scholar and an affront to the Sultan. Al-Bīrūnī could not have visited the Punjab or returned to Ghaznah after antagonising the Sultan. Therefore, it is logical to assume that whenever al-Bīrūnī went to India he had the tacit approval of the Sultan. Likewise, the Sultan could not allow him to keep away from his court for a long period.

After al-Bīrūnī passed the age of fifty, i.e., after 1023 A.D., he suffered a very serious set-back in his health.¹⁸³ This breakdown was probably a result of his strenuous exertions in the sub-continent. Moreover the *Kitāb al-Hind* was being written down after al-Bīrūnī's return. Its writing had to start some years before 1030 A.D. In this way the only time for his visit to the sub-continent and which corresponds to al-Bīrūnī's subsequent activities was 1020–24 A.D. In these four years it was a difficult task for a man of nearly forty-seven years of age to learn foreign language with an entirely different alphabet, to master the secrets of foreign knowledge and to understand the exotic beliefs. He could have learnt Sanskrit only from a man who also knew Persian or Arabic otherwise al-Bīrūnī might have picked up some western Indian dialect.

CONTACTS WITH INDIANS

His two years' stay at Kabul during 1018–20 A.D. provided him with ample opportunities either to learn Indian dialects or to acquire knowledge of Sanskrit from some Persian-knowing Hindu residents of Ghaznah. This assumption is further corroborated by al-Bīrūnī's own statement that in India he tried to learn the secrets of astronomy from Indian astronomers. He states: "At first I stood to their astronomers in the relation of a pupil to his master, being a stranger among them and not acquainted with their peculiar and traditional methods of sciences". Here he did not refer to any

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problem relating to his learning the language. Furthermore, an Indian could be expected to converse with a Sanskrit-knowing foreigner but not teach him his sacred language.¹⁸⁴

Al-Bīrūnī was an insatiable seeker of knowledge. He was always ready to seize upon every opportunity to increase his knowledge. As a captive passing through Kabul he measured its latitude. He patiently made a search for a book of Mānī and succeeded in securing it after forty years. He was a keen student of Indian sciences (mathematics and astronomy) and was aware of the confusions in the early translations of Indian works. His desire to know the actual and original versions of these works was present with him all the time. His stay at Ghaznah provided him an opportunity to learn Sanskrit. He could have studied some works at Ghaznah also but one cannot be certain on this point.¹⁸⁵ The thoroughness of his knowledge of India, embracing a bewildering number of fields; grammar, literature, religion, astronomy, mathematics, beliefs, geography etc., envisages a prolonged and a continuous stay or repeated visits.

He visited the areas where he could go in peace viz., the Yamīnī dominions in the Punjab. Multan, the old pilgrim centre of Hinduism still had some scholars whose books helped him e.g., Balabhadhra. He also visited Sialkot and Nandana probably in search of knowledge from Kashmiri scholars, for Kashmir and Varanasi (Benares) were the two great centres of Indian learning in the north of India. His visit to these towns was probably due to his projected scheme of making Ghaznah a centre of astronomical and scientific studies including the studies in latitudes and longitudes. He had information about regions west of Ghaznah upto Alexandria. He had himself carried on measurements in Khwārizm. The studies in Afghanistan and India completed this project. During these visits he found an ideal position at Nandana to put to test his trigonometrical method of measuring the earth's circumference. The above discussion shows that al-Bīrūnī did not accompany Mahmūd on his expeditions, a fact which is corroborated by a study of the latter's expeditions after 1017 A.D., whose dates are given below:

- | | |
|---|--|
| I. Qannauj | 13 <i>Jamādī</i> I, 409 A.H., 27th September 1018 to beginning of 1019 A.D. |
| II. Tirlochanpal of Qannauj Bari and Ganda of Kaling | October 1019–1029 A.D. |
| III. Kashmir | September 1021 – April 1022 A.D. |
| IV. Gwalior and Kalinjar | 1022 – April 1023 A.D. |
| V. Somnath | 10 October 1025 – 2 April 1026 A.D. |
| VI. Jats of Sind | March 1027 – July 1027 A.D. |

Out of these the first expedition is out of question because when al-Bīrūnī reached Ghaznah in 1018 A.D., Maḥmūd had already left for Qannauj. As al-Bīrūnī did not visit Qannauj, Kalinjar, Somnath or Sind it may be inferred that he did not accompany Maḥmūd on these expeditions. At the most he might have started with Maḥmūd for India on his expedition to Kalinjar and could have remained behind in the Punjab. But it is too much to believe that he accompanied Maḥmūd in 1019–20, 1021–23 A.D. and continued his studies as well. If Maḥmūd had kept al-Bīrūnī as an astrologer in his expeditions, he could not have allowed him to remain behind.

Al-Bīrūnī visited different cities of the Punjab some of them 200 miles away from each other. It appears that in the direction of Kashmir, he went as far as the fort of Rājāgiri situated on the southern side of the Kularjak, a cupola-like peak while on the western side was the fortress of Lahūr (Lahore) while beyond it at a distance of two *farsakh* was the plateau of Kashmir.¹⁸⁶ Along with Lahore it was one of the strongest forts ever seen by al-Bīrūnī.¹⁸⁷ These forts had to be strongholds for they served as the frontier posts of Ghaznah towards Kashmir, a place of refuge for the fugitive Hindu Shāhiya princes and the only place, which, helped by forces of nature, defied the great Sultan.¹⁸⁸

It was probably at these places that al-Bīrūnī came into contact with the Indian scholars. The physical distances between lower ranges and the southern Punjab and the closer proximity of

Sialkot, Nandana, Lahore and Jhelum to each other tempts one to conclude with some plausibility that al-Bīrūnī most likely visited these cities in one journey. Another journey could have taken him to Multan, especially as he mentioned Sialkot and Mudarkar together after referring to Lahore and Nandana etc. It could have meant that he visited them in one journey and the rest in another.

The people of Multan told al-Bīrūnī that there was no *varashkāla* (rainy season) in their region, as al-Bīrūnī never visited the province of Sind because he was after the sources of Indian learning which had withered away in that region due to the conversion of the people to Islam and the animosity of the Ismā'īlīs.¹⁸⁹ The cities of Alore, Maṣūrah and Debal had developed into centres of Islamic learning.¹⁹⁰ However, Multan still continued to have some remnants of ancient learning which were extensively used by the learning Indologist.¹⁹¹ So al-Bīrūnī seems to have travelled along Kabul and the Punjab routes. Along this route, monsoon conditions and the inundations in the seven rivers (*Sapta Sindhu*) made travelling difficult in the rainy season (i.e. July-October). At the same time the intense summer heat of Multan and the Punjab enervated the visitors coming from the cool hilly regions of Afghanistan and Central Asia. Consequently, any one trying to visit the cities of the Punjab had to choose the winter when the snow and severe cold made journey from Afghanistan to north-west very difficult. In this way al-Bīrūnī can be deemed to have visited the sub-continent in winters probably starting from Ghaznah in September-October.¹⁹² So there is no surprise that from Sialkot he moved towards Multan.¹⁹³ He might have accompanied the hordes of Mahmūd on the second expedition to Kashmir (September 1021 – April 1022 A.D.) or the expedition to Gwalior, Kalinjar etc. (1022 – April 1023 A.D.). In 1025–26 and 1027 A.D. he was busy with his work at Ghaznah and so could not have been part of the last two expeditions. However, if he did accompany the Sultan, he must have sought and secured prior permission to stay back in the Punjab.

Mahmūd had no love for Hindu sciences. He was an orthodox Muslim and was not ready to accept something new as the phenomenon of the sun moving around the earth on the North

Pole. He could not be a Hārūn or Ma'mūn for Indian knowledge and patronise its acquisition, therefore, he could not have been keen on taking al-Bīrūnī to India for the sake of his Indian studies. Al-Bīrūnī's thirst for knowledge was sufficient for motivating him to learn the Indian sciences. Therefore, the great scholar could have himself contrived to visit India, though with the Sultan's permission.

He took full advantage of the available opportunity, neither sparing effort nor money to procure books and information available to him in western India. But he was not satisfied and yearned for greater scope and resources of acquiring the best knowledge.

It is suggested that after his visits to the sub-continent, al-Bīrūnī was unable to add further to his acquired knowledge from that source. It is true that he was unable to come into contact with other great Indian works other than those that he had studied. Yet his contacts with India were never broken. After his return from India he carried on correspondence with Indian astronomers and scholars of Kashmir who posed certain questions to him. These questions could have been posed to him only after his fame as the *sāgar* (ocean) and wizard of knowledge¹⁹⁴ had spread and possibly when he had returned to Ghaznah. When he completed *al-Hind* (1030 A.D.) his information about the latitudes and longitudes of other Indian towns was confined only upto the towns of the Punjab, which he himself visited or to the towns of Sind, Malwa and *Madhya Desha* (modern Uttar Pradesh) only, about which he had learnt from the Arab and Indian authorities. But he wanted to acquire more geodetical information about the places he had visited.¹⁹⁵ In the *Qānūn al-Mas'ūdī* one finds references to the southern Indian cities of Tanjore, Rameshwaram and others as well. Not having taken their measurements himself, he must have copied them from some treatise. Thus he was still keen and making efforts to learn about India, or any other knowledge, however, time and growing physical infirmity hampered his efforts to know more about the Hindu eras.¹⁹⁶

Sultān Mahmūd has been depicted as an iconoclast zealot who suppressed the Hindus, though, in fact, his aggrandizement was as manifest in the Muslim regions of Central Asia and Iran

as in India. No doubt he was a great conqueror but he never destroyed any temple in peace time. He was tolerant towards Hindus. They lived without any apparent molestation, free from forcible proselytization in Ghaznah, Kabul and the Punjab. They even found service with the Sultan. However, the most outstanding and unique proof of the Sultan's care for his non-Muslim subjects was the issuing of a bilingual currency bearing legends both in Arabic and Sanskrit. Some of these coins which have been found yet bear the years 1021 A.D. and 1028 A.D. as the date of their issue.¹⁹⁷

It has been suggested that the idea of bilingual coins with Sanskrit translation was suggested by al-Bīrūnī for he was the only Indophile-Muslim living at that time. The argument has been stretched further with the suggestion that this act of al-Bīrūnī shows him to be a champion of the right of self-determination.¹⁹⁸ This argument is too far-fetched and tends to confuse the proper perspective in which the life of the great master should be studied.

If al-Bīrūnī persuaded Maḥmūd to adopt the bilingual currency he had to be in favour with the Sultan who was averse to any *bid'ah* (innovation). He regarded the statement about the apparent revolving of the sun around the poles as blasphemy, and declared the man as a *mulhid* and a *qarmatī*. Nevertheless he was reasonable and was ready to give a patient hearing to the propounding of theories. On the suggestion of Abi Naṣr Maṣḥkān he put the question to al-Bīrūnī who explained the whole phenomenon briefly but clearly. Al-Bīrūnī did not venture to hazard an explanation of the problem on his own. The court etiquette forbade such direct mode of speech and after the bitter memories of his abortive dabbling in political affairs at Khwārizm, al-Bīrūnī could not court any new disaster. Therefore, it may be said that al-Bīrūnī or for that reason any other person could have found it very difficult to persuade the Sultan to translate the *Kalimah* into the language of the non-Muslim. Besides, in 1021 A.D. al-Bīrūnī was probably in India learning the sciences. It is possible that he suggested the change after he had learnt Sanskrit at Ghaznah. However, this hypothesis would deprive the Sultan of the credit of this well-meaning gesture. In that period threats of the Carmathian doctrines

had caused great alarm and the Sultan was the strongest *Sunni* ruler and regarded as the champion of that faith. Ismā'īlīs were the extreme branch of the Carmathians. They opposed the Caliphate and the *Sunnah*, the two tenets of orthodoxy. Forming into strong bands of marauders and saboteurs, they roved areas as far distant as Yemen and Khurasan. "Their secret organization, based on Ismā'ilite antecedents, developed an agnosticism which aimed to emancipate the initiate from the trammels of doctrine, enlightened him as to the superfluity of Prophets and encouraged to believe nothing and dare all". People looked to Maḥmūd for saving the *Sunni* doctrine. He could himself have sincerely believed that it was his duty to save his creed. Therefore, it was natural for him to execute Tāhartī, the Ismā'īlī *dā'ī*,¹⁹⁹ destroy the Carmathians of Multan, the Buwayhids of Rayy and Isfahan, and burn publicly the letter and robe of honour sent by the Fātimid Caliph.²⁰⁰ Notwithstanding his abhorrence for heterodox Islamic doctrines, he was a just ruler and knew that it was the duty to protect and even employ, his non-Muslim subjects as well. Such a policy was not suggested by any person. Rather the pragmatic approach of Maḥmūd could have made him adopt a policy of reconciliation towards the non-Muslim who still constituted the majority of the population of Afghanistan and the Punjab. When Hindus could live in Ghaznah, serve the *malichchha* Maḥmūd and teach a *malichchha* scholar their *devbānī* (the language of gods or Sanskrit), surely one of them could have come forward to translate the legend. Maḥmūd had a number of persons well-versed in Indian languages at his disposal. They were required to help him in conducting his expeditions into India or in negotiations. One such person translated the Hindi verse composed by Ganda, the Raja of Kalinjar, in praise of the Sultan.²⁰¹

Therefore, the suggestion could or could not have come from al-Bīrūnī who with his acquaintance with Sanskrit was in a position to be entrusted with the translation itself or might have remained associated with the work. But we do not know for certain.

Let us consider the translations themselves.

Avyaktam ekam, Muhammada avatāra

“There is no god but God and Muḥammad is the Apostle of Allāh”.

This silver coin has been struck in the *ghatta* (mint) at Muḥammadpūr, i.e., Lahore

Ayam Tankah Muḥammadapure ghatta āhatah

King Maḥmūd ... in the year of the passing of the Prophet (more correctly *Hijra* or Migration).

Nirpati Maḥmūda; Jin āyana Samvati

In one case *Bismillāh* has been translated as *avyaktiya-name*.

The Sanskrit translation of the *Kalimah* is not a literal translation and it runs something like this: “The Formless (Divinity) is One, and Muḥammad is His incarnation.”²⁰²

The other phrase which merits consideration is the translation of *Hijra* since *Jin ayana* means the passing or the migration of *Jina*.

It has been suggested that as Sanskrit had no equivalent word for *Allāh*, *avyaktam ekam* denoting Formlessness of God, an essential characteristic of God according to the Muslim belief, was a permissible departure. It maintained the spirit, if not the literal form of the *Kalimah* as *Jin ayana Samvati* shows a careful translation giving the correct picture of the Muslim era’s origin. As al-Bīrūnī had used the term *avyaktam* having the same meaning and had also used *Jina* in respect of Buddha (*Jīna, wāḥūwa al-Buddū*), denoting him as the founder of the creed and as the great scholar was so well informed about Indian beliefs, he may be regarded as the likely author of this translation.

However, so far only the first portion of the *Kalimah* has been discussed. The second part which is also as important for Muslim belief as the first one has been improperly translated. The Prophet (peace be on him) has been declared an incarnation of God, which was tantamount to the deification of the Prophet (peace be on him), an occurrence similar to certain doctrines where ‘Alī had been raised to the status of divinity.²⁰³ Such a picture of the Prophet was therefore tantamount to heresy for the Sultan and *Sunni* Muslims. The erroneous representation through mistranslation has been attributed to the Sufistic influences. However, al-Bīrūnī a scientist by nature did not see eye to eye with the *ṣūfīs*. He severely criticised

Manṣūr Hallāj and roundly condemned him for his heterodox beliefs. He was fair in his translations and was ready to criticise any wrong translations that did not conform to truth. He could not be expected to commit such a blunder. Moreover, the use of *avatam* and *Jina* by al-Bīrūnī could be a coincidence. In view of the mistranslation of the word *rasūl* it is difficult to subscribe to the view that al-Bīrūnī translated the *Kalimah*. Had he been associated with the translation, he could not have allowed such an egregious mistake to creep in. However, in the present stage of our knowledge it is not possible to determine the identity of the person responsible for the translation of the legend or for suggesting the idea of bilingual currency. Al-Bīrūnī was one of the likely persons who could have been associated with the work but as he never ventured to give suggestions on his own, the idea was probably suggested by someone else or it could have been the Sultan's own decision. Whoever did the translation, the mistake about *rasūl* remained unnoticed.

No doubt Mahmūd did not accord al-Bīrūnī the respect and patronage as Qābūs and Mas'ūd did. In the courts of the last two rulers al-Bīrūnī was given precedence over other scholars and was the main recipient of the royal favours. There were many learned men at Mahmūd's court and al-Bīrūnī was one of these luminaries.²⁰⁴ However, Mahmūd's patronage revived the fortunes of the great scientist, his 'looks and dress' improved. He was consulted to give his opinions on difficult matters relating to astronomy. He was shown priceless precious stones for his opinion and evaluation. He was asked to interview embassies. He made Ghaznah the centre of his astronomical and geographical studies and designated one of his instrument as the *Yamīnī* ring.²⁰⁵ It is true that Mahmūd took no direct initiative in encouraging him in his Indian studies but he neither imprisoned him nor put restrictions on his movements. It may be pointed out that his thirteen years' life under Mahmūd's reign contributed to the maturity of his scientific ideas and theories. The rest of his life was spent in giving finishing touches to these studies or preparing fair copies of his treatises including his *magnum opus*, *Qānūn al-Mas'ūdī*. So whatever, therefore, the controversies regarding his stay in the

court of Maḥmūd, the importance of that period in the life of al-Bīrūnī cannot be overlooked. In that age when astrology was so popular, al-Bīrūnī a great adept in the occult art, was not overlooked; so much so that later anecdotes were woven about his prowess. It was reported by *Chahār-Maqālah* that Maḥmūd tested the great astronomer's skill and finding the answers ready, became angry, for his ego could not tolerate correct answers to both of his queries. So al-Bīrūnī suffered six months confinement.²⁰⁶ However, the story is apocryphal.

When al-Bīrūnī was more than fifty years of age (after 1023 A.D.) he fell seriously ill. Probably it was due to the hardships he had undergone in visiting India and the intense amount of labour he had put in for acquiring mastery over Sanskrit and Indian sciences. He grew very weak and thin, but he was able to overcome it. His efforts to overcome his illness appear to be successful for he continued to live upto 1048 A.D. (upto the age of 75) and was apparently able to finish most of his books.

RELATIONS WITH MAS'ŪD

After the death of Maḥmūd (30 April 1030 A.D.) till the accession of Mas'ūd about a year later, the city of Ghaznah remained under the control of Muḥammad, the younger son of Maḥmūd. Uncertain conditions prevailed and the scholars and *ulema* were not sure of their future. However, Mas'ūd was popular and the army and the chiefs refused to acknowledge Muḥammad. Muḥammad was deposed and imprisoned in Tagīnābād. In 1031 A.D. Mas'ūd was crowned king at Ghaznah. He immediately recalled Aḥmad b. Ḥasan Maymandī who had been earlier removed from *wizārat* and imprisoned by Maḥmūd in 1025 A.D. It seems that the change of monarchs and restoration of Maymandī proved beneficial to al-Bīrūnī.

The year following the death of Maḥmūd saw the great scientist cast into the doldrums. He had completed his researches and had made Ghaznah the centre of his studies. He was in his fifty-eighth year and he was afraid that he might have to leave Ghaznah. Not only would this mean disruption of his studies but a possible loss

of his books, instruments, and the fruit of thirteen years of labour. Probably his ode in the praise of Abū al-Faḥ of Bust belongs to this period. He felt depressed and bemoaned the loss of his patrons.²⁰⁷

Mas'ūd was a drunkard and a short-sighted ruler. He treated his subjects cruelly and arbitrarily.²⁰⁸ His stubborn and haughty nature had once brought him as a prisoner to Multan in the lifetime of his father (1021–22 A.D.). The relations between the father and the son deteriorated and Sultan Maḥmūd appointed Muḥammad as his successor. It is said that Mas'ūd after his coronation began to wreak vengeance on those who had received rewards from Maḥmūd and on those who belonged to the opposition.²⁰⁹ Al-Bīrūnī caught between the devil and the deep sea, retained his equanimity and with his vast experience knew which way the wind was blowing. He was not ready to jeopardize his studies and researches. Maḥmūd and Mas'ūd were important to the extent that they helped him to pursue and complete these studies. He knew that patronage of kings was essential for the development of knowledge. Mas'ūd's succession and recall of Maymandī to *wizārat* initiated an anti-Maḥmūd trend. Al-Bīrūnī could have taken advantage of it.

QĀNŪN AL-MAS'ŪDĪ

It may be assumed that al-Bīrūnī's sad plight in 1030 A.D. was due probably to his pro-Maḥmūd affiliations, or his neutrality. It cannot be said how much time al-Bīrūnī took in ingratiating himself with the new Sultan. His careful and cautious attitude, and Mas'ūd's love for sciences, particularly for astronomy drew them closer. However, in 1034–35 A.D. he had written to a friend that he desired God's help, shelter from things that disturb study and thinking, a long life with full control of senses, and suitable health for completing his unfinished books. Meanwhile he had decided to name his *magnum opus* as *Qānūn al-Mas'ūdī*. For he found the new Sultan fond of astronomy and *ḥaqā'iq-i-ʿilmiah*. 'Ilm in Mas'ūd's court was placed on a high pedestal. The best means of securing his *qurb* (close association) was through 'ilm. The Sultan allowed

him during his last years of life to serve the cause of learning, made friends with him, took him under his patronage and showered his benevolences upon him, which included financial help. The scientist himself belonged to *riyādi* (mathematics); he had devoted himself to that science and was known through it, therefore, he decided to serve the Sultan in *'ilm-i-hay'iyat* (*Ṣana'at al-Tanjīm* or astronomy) by composing its *Qānūn*.²¹⁰

Mas'ūd inquired from al-Bīrūnī the reason about differences in the duration of day and night in different countries and why the sun does not set at the poles. Al-Bīrūnī wrote the *Kitāb layl wa al-nahār* for Mas'ūd in an easy language. Mas'ūd knew Arabic and was highly pleased with the book. He also asked al-Bīrūnī to write *Lawāzim al-harakatīn*. Mas'ūd was liberal and friendly to *ulema* and obliging in nature. An accomplished calligraphist, he was wont to give large rewards. At one time he awarded one thousand *dīnārs* for an ode and at another occasion gave one thousand *dirham* for each couplet.²¹¹ It is said that on the completion of *Qānūn al-Mas'ūdī*, the Sultan bestowed an elephant load of silver on the author. But al-Bīrūnī was then disinterested in worldly goods and therefore returned it. He had become fully wedded to study, and he passed all his day in reading and writing. His desire for long life was prompted less by love for this world than by fear that he may not be able to finish his work before his end.

RELATIONS WITH MAWDŪD

Short sighted policies led to Mas'ūd's defeat at the hands of the Seljuqs at Dandaqān 1039 A.D. He lost heart and tried to retreat to his Indian possessions with his family and brother Muḥammad. However, his failure had sealed his fate. Anushtagīn Balkhi, Mas'ūd's slaves and the Hindu soldiers revolted. Mas'ūd was defeated and took shelter in Marikāla where Aḥmad b. Muḥammad killed him (1040 A.D.). But Muḥammad was unable to control things. Mawdūd b. Mas'ūd was at Balkh. Hearing about his father's tragic end, he came to Ghaznah. He defeated Muḥammad at Dinūr. Muḥammad, his son Aḥmad and Anushtagīn were executed. Majdūd who had been appointed by his father Mas'ūd in Hind in 1034 A.D.

came forward to check Mawdūd but died before the battle. Thus Mawdūd was enthroned and ruled upto 1049 A.D.²¹² He was the last Ghaznawid ruler whose reign was witnessed by al-Bīrūnī. He was known for his justice and good character. He continued fighting the Seljuqs and kept them confined to Khurasan and Mawrā' al-Nahar (Transoxiana) and checked their expansion towards India. He also saved Lahore from the combined attack of Hindu *rajas*. Al-Bīrūnī continued his studies, living in comfort and respect.²¹³ He wrote the *Kitāb al-jamāhir fī'l-jawāhar* also (*al-Jamāhir fī ma'arif al-jawāhir*), and also dedicated his *Kitāb al-dastūr*, dealing with the best qualities, to that ruler.

DEATH OF AL-BĪRŪNĪ

It was during Mawdūd's time that al-Bīrūnī after living thirty one years under the Yamīnī dynasty died probably on 11th September 1048 A.D. (12 *Rajab* 440 A.H.). Even when he was facing the frailties of an approaching end his appetite for knowledge did not diminish. The *Kitāb al-Saydanah* was thus written during the period when the great master was nearing the end of his life, and he employed an amanuensis for the purpose. He himself has confessed in that book that his eye-sight was failing him. The work seems to have been in the form as compiled, for it is replete with repetitions and the author has at times forgotten to say about drugs in another *radīf*, while in the previous *radīf* he has said that it would be described under such and such *radīf*.

Faqīh Abū al-Hasan paid him a visit before his death. The great scientist did not want to let his last moments pass without learning something. He asked the *faqīh* to tell him again the account of *jadāt al-fāsīdah*, memorized it and repeated it correctly. When Abū al-Hasan came out he heard the wailings of women.²¹⁴ The great scientist had passed away into the great Universe beyond.

CHAPTER IV

AL-BĪRŪNĪ'S PREDECESSORS AND CONTEMPORARIES

Though al-Bīrūnī was born in 973 A.D., his academic career and creative activities started some years before the end of the first millennium of the Christian era. As his academic life covers nearly the first half of the first century of the succeeding millennium this period (1000–1050 A.D.) can be designated as the age of al-Bīrūnī.²¹⁵ It was just before the age of Kḥayyām, the last glorious chapter of the creative Muslim literary and scholarly activity. This grand era of the development of human knowledge and learning was initiated by the Arabs. However, it is said that the Arabs had a great flair for the studies pertaining to the language (i.e. Arabic) and religion only, both of which were indigenous products of the Arab society.²¹⁶ Owing to the similarity in the nature of study the above two branches have earned the designation of *manqūlāt*, that is, disciplines which are acquired by learning and memorisation without the use of reason. At the same time the non-Arabs, e.g., the Christians and the Iranians became proficient in other fields of study viz., (a) logic, (b) the peripatetic sciences, (c) physics, and (d) science of society,²¹⁷ while the Turks by and large seems to have exerted themselves in building huge empires and monuments, and in mastering the art of statesmanship.

The Arabs, however, were not completely barren of creative spirit in the field of physical sciences. In al-Kindī (801–873 A.D.) and al-Haytham (965–1030 A.D.) besides others, they possessed two of the finest philosophers and scientists. Nevertheless, the titles of *mu'allim al-thānī* and *mu'allim al-thālith* were reserved for non-Arabs, viz., Abū Naṣr Fārābī and Ibn Sīnā both belonging

to the region of Central Asia, the former being a thoroughbred Turk.

The age which produced al-Bīrūnī and Ibn Sīnā was preceded by a period of great literary activity in the regions of Khurasan and Central Asia. Medicine, philosophy, mathematics and astronomy were the four main branches in which a number of Iranian and Central Asian scholars made definite contributions. Their work and tradition finally produced the two great Masters, al-Bīrūnī and Ibn Sīnā. A brief survey of the contribution made by these scholars and their influence on the lives of al-Bīrūnī and Ibn Sīnā will be conducive to a better understanding of the life of the great Masters.

ABŪ 'ABD ALLĀH MUHAMMAD IBN MŪSĀ AL-KHWĀRIZMĪ (863 A.D.)

When Jābir ibn Haiyān (721–815 A.D.), al-Kīndī (801–873 A.D.), Hunayn ibn Ishāq (810–877), and Thābit ibn al-Qurrah (826, probably 836–901 A.D.) were laying the foundations of Muslim science and philosophy on the basis of the Hellenistic and neo-Platonic knowledge under the aegis of the 'Abbāsids, a Central Asian scholar was trying to co-ordinate the recently acquired Greek knowledge in mathematics with the newly presented Indian learning. He was called Mūsā al-Khwārizmī, Abū 'Abd Allāh Muhammad Ibn Mūsā al-Khwārizmī (863 A.D.).²¹⁸ Prior to al-Khwārizmī the Muslim mathematics was in its infancy. Knowledge of figures and numbers acquired from the Greeks and the Indians was present but it awaited further synchronising and evaluation. Born in the town of Khwārizm he visited Baghdad and rose to be one of the well-known scholars and scientists at the court of Ma'mūn. Some later historians said that he visited India as well, a supposition which was probably born, out of his mastery over Indian knowledge. His influence on mathematics exceeds that of any other mediaeval scholar. He made known to the Arabs and the Europeans the Hindu system of numeration.

Al-Khwārizmī in the company of other astronomers under instructions of Ma'mūn measured the degree of arc and worked out the earth's circumference.



Abū 'Abd Allāh Muḥammad ibn Jābir ibn Mūsā al-Khwarizmi

He was one of the founders of analytical algebra as distinct from geometry. His famous treatise *Hisāb al-jabar wa al-muqāblah*, the first Muslim work on this subject gave its name to the new science of *algebra*. He provided analytical solutions of linear and quadratic equations. His astronomical *zij* (table) and trigonometric tables (with sine and tangent) became the basis of further researches for his successors including his countryman, al-Bīrūnī, who defended his celebrated predecessor against the attacks of Abū Talḥah and Abū al-Hasan Ahwāzī.²¹⁹ It seems that al-Bīrūnī preferred Kḥwārizmī to Ḥabash. He also revised and improved the geography of Ptolemy.

ABŪ AL-'ABBĀS AHMAD B. MUḤAMMAD B. KATHĪR AL-FARGHĀNĪ
(ALFRAGANUS)

He hailed from Farghana in Transoxiana and flourished at the court of al-Ma'mūn. His *Kitāb fī Harakat al-Samāwiyah wa jawāmī' 'ilm al-nujūm* (Elements of Astronomy) exerted great influence. Together with al-Kḥwārizmī and other scientists he established a rich tradition of astronomical and mathematical studies in Central Asia. He accepted Ptolemy's theory of precession, but thought that it affected not only the stars but also the planets.

ABŪ MA'SHAR JA'FAR B. MUḤAMMAD B. 'UMAR AL-BALKHĪ

He also flourished at Baghdad and died in 866 A.D. at Wasit at an advanced age. A number of astrological writings are attributed to him. The most important was the *Kitāb al-Mudkhal 'ila 'ilm al-ḥkām al-nujūm* (The Great Book of Introduction to Astronomy). Al-Bīrūnī wrote his *'il al-zij al-Makani ba bi Ma'shar* about the *zij* of Abū Ma'shar.²²⁰

ABŪ 'ABD ALLĀH MUḤAMMAD IBN JĀBIR IBN SINĀN AL-BATTĀNĪ

He was born in 858 A.D. and died in 929 A.D. He was one of the greatest astronomers of Islam. He found that the longitudes of the sun's apogee had increased by 16°47' since Ptolemy's time.



Abū 'Abd Allāh Muḥammad ibn Jābir ibn Sīnān al-Battānī

i.e., it reflected the motion of the solar apsidal and a slow variation in the equation of time. He proved the possibility of annular solar eclipses.

He completed the introduction of the functions *umbra extensa* and *umbra versa*. He knew the relation between the sides and angles of a spherical triangle, viz., $\cos a = \cos b \cos c + \sin b \sin c \sin a$.²²¹ Al-Bīrūnī studied his astronomical findings and wrote a treatise on *zij al-Battani*.

ABŪ AL-WAFĀ MUHAMMAD B. MUHAMMAD B. YAHYĀ' B.
ISMĀ'ĪL B. AL-'ABBĀS AL-BUZJĀNĪ

He was born at Buzjan and died in Baghdad (997 or 998 A.D.). He wrote commentaries on Euclid, Diophantos and al-Khwārizmī (all non-extant). However, he contributed considerably to the development of trigonometry and was probably among the first to show the generality of the sine theorem relative to spherical triangles and introduced a new method of constructing sine tables, the value of sine 30° being correct to the eighth decimal place. He also made a special study of the tangent, calculated a table of tangents and introduced the secant and cosecant.

ABŪ MUHAMMAD HĀMID IBN AL-KHIDR AL-KHujandĪ

He came from Khujand on the Jaxartes (Sir Darya) in Transoxiana (d. 1000) Abū al-Wafā in Baghdad and Al-Khujandī at Rayy were greatly responsible for making these two places centres of mathematical and astronomical studies. Besides determining the obliquity of the ecliptic in Rayy in 994 A.D., he was also credited with the discovery of the sine theorem relative to spherical triangles.

ABŪ NAṢR MANṢŪR IBN 'ALĪ IBN 'IRĀQ

He was a prince of the ruling dynasty of Kāth, the birth-place of al-Bīrūnī. His main claim rests upon his learning and also upon the patronage he extended to al-Bīrūnī. He was also credited with

the discovery of sine theorem relative to spherical triangles. Probably Abū al-Wafā, al-Khujandī and Abū Naṣr Maṣṣūr reached these conclusions independently of each other. The intensive researches carried on in the Islamic society of that period was not confined, to one region and such a development at places as far placed as Baghdad, Rayy in Khurasan, and Kāth in Khwārizm, was possible.

He was primarily responsible for helping in the development of al-Bīrūnī's studies in these fields. He was the latter's patron, teacher and friend. His attachment to his celebrated disciple is vouchsafed by the fact that he wrote twelve of his books in the latter's name as mentioned by al-Bīrūnī himself. These books were mainly devoted to astronomy and mathematics.²²²

ABŪ NAṢR MUḤAMMAD B. MUḤAMMAD B. TARKHĀN
B. UZLAGH AL-FĀRĀBĪ: (ALPHARABIUS)

Al-Fārābī was born at Wāsiy near Fārāb in Turkistan. He studied at Baghdad and visited Aleppo, Egypt and Damascus where he died in 950–951 A.D. at the age of about 80. Though he is claimed by the Arabs, the Iranians and the Turks, he is generally believed to be of Turkish stock.²²³

Al-Kindī was the first Muslim philosopher and an encyclopaedist-scientist who not only introduced a technical philosophic vocabulary but also adopted the peripatetic Aristotelian and neo-Platonic doctrines to Islam. In the East its discursive and syllogistic style culminated in al-Fārābī and Ibn Sīnā while its rationalistic aspect ended in the West in Ibn Ruṣhd (Averroes).

Al-Fārābī's system was a syncretism of Platonism, Aristotelianism and Sūfism. He continued the tradition of al-Kindī preparing the way for Ibn Sīnā. Some of his important works were the *Risālah fuṣūṣ al-ḥikam*, *Risālah fī mabādī ārā' ahl al-Madīna al-fādilah* (The Organization of an Ideal City). His treatises on the classification and fundamental principles of sciences, e.g. the *Kitāb ihṣā al-'ulūm* (De Scientiis) and *De Ortu Scientiarum* (non-extant in Arabic), were basically the peripatetic classification transmitted through Philoponos's Commentary on the Isagoge.²²⁴

Among scholars and men of learning who influenced al-Bīrūnī indirectly or with whom he came into direct contact was Ibn Sīnā, a successor to Fārābī in peripatetic studies.

Abū 'Alī al-Husayn Ibn Sīnā was born seven years after al-Bīrūnī at Afshāna near Bukhara (980 A.D.). He died at Hamadan in 1037 A.D. He belonged to an Ismā'īlī family but refused to accept its doctrine. His father's death compelled him to move to Gurgānj where Abū al-Husayn Suhaylī procured for him a handsome and adequate salary. From Gurgānj he probably moved after al-Suhaylī's dismissal and wandered from place to place trying to reach Jurjān's ruler Qābūs, a great patron of learning. From Jurjān the master moved to Rayy, then Qazwin, Hamadan and finally came to Isfahan. In these troubled days his healing skill helped him overcoming obstacles and acquiring lucrative assignments. However, growing infirmity due to age and circumstances brought his life to a close in 1037 A.D. at the age of fifty eight years.²²⁵

Ibn Sīnā was seven years younger than Abū Rayhān al-Bīrūnī. He was a voracious reader and a prolific writer. His first book, a comprehensive *Majmu'* (Compendium) was written at the age of twenty-one. He soon became celebrated for his skill in medicine and in peripatetic studies, so much so that al-Bīrūnī sent him a number of questions attacking some of the observations of Aristotle.

An aura of mystery and romance shrouds this clash between the two greatest geniuses of the age and among the most original and generative intellects of all times. Even the place and time of these exchanges is obscure. Al-Bīrūnī referred to this episode in the *Chronology* which was probably composed near about 1000 A.D.²²⁶ and Ibn Sīnā was twenty-one years of age. It was the time when Ibn Sīnā's fame was unfolding and this could have galled the pride of al-Bīrūnī.

Al-Bīrūnī could have sent the questions directly through a messenger. It was the usual custom of the age. Al-Bīrūnī received such queries from the astronomers of India and from the scholars

of Kashmir. Later at Isfahan, Ibn Sīnā received another set of such queries from the scholars of Shiraz who had taken exception to a number of statements in *al-Mukhtasar al-Asghar*.²²⁷

The exchanges between al-Bīrūnī and Ibn Sīnā not only show the working of the two great minds of their age, their unity and contradictions, development of ideas in peripatetic and non-peripatetic schools of thought, and approach to problems; but also reflect upon the scientific spirit of research and inquiry diffusing during that period.

The questions were:²²⁸

1. Aristotle has no sound reason for his supposition that the Heavens are neither heavy nor light.

2. Aristotle's method of seeking support for his theories in the opinions of former thinkers (in respect of the idea that the universe had no beginning) is improper.²²⁹

3. Aristotle is not right in restricting the number of directions to six only, as it could be imagined to be many more, and may really be unlimited.

4. Aristotle's reasons for rejecting the atomic theory are not sound and his own theory of the infinite divisibility of matter is no less open to objection.

5. Aristotle is not justified in denying the possibility of the existence of other universes besides our own.

6. There is nothing wrong in imagining the forms of Heavens as elliptic. Aristotle's reason for making them spherical is hardly convincing.

7. Aristotle is not justified in saying that the Heavens move from the east, as the east is the right side. Right and left are merely relative terms.

8. There is no reason for Aristotle's supposition of sphericity of the fire.

9. How is heat imparted through the rays of the sun and are the rays themselves material, or indicate a condition of something else?

10. Aristotle's theories about chemical changes are not based on sound reasons.

11. How does a round flask of glass, full of water, burn things opposite to it, while the same filled with other elements, e.g., the air, does not do so?
12. Do all the four elements move to their centres or does only earth or water gravitate, while air and fire move from the centre to their enclosing spheres?
13. What is the nature of vision? How do we see below the water?
14. Why is only one quarter of the earth supposed to be inhabitable, while the other three are equally capable of being so?
15. Why do vessels break by the solidification of water?
16. Why does the ice float on water?

These questions generally refer to the nature of heaven and universe, the problems of gravitation, division of atom, nature of fire (heat) and its induction, refraction of rays and vision, directions, study of natural phenomenon i.e., breaking of vessels and floating of ice. There is no reference to any astronomical or mathematical problem. Probably al-Bīrūnī did not consider much of Ibn Sīnā's achievements in these fields. The questions at the same time show al-Bīrūnī's complete comprehension over the peripatetic studies and to exact sciences as well, which is further confirmed by his correspondence over some of these problems.

In the question dealing with the possible gravity of heavens, their circular motion and the denial of the natural place of things al-Bīrūnī said:

Since the heavens have no motion towards, or away from the centre, Aristotle has not accepted the idea of the gravity of the heavens. However, such reasoning by Aristotle does not really aim at the desired end. It is possible to imagine that the heavens do possess a gravity which, however, does not cause them to move towards the centre, insofar as each part of the heavens is like every other part. Having hypothesized their gravity, one may say that, whenever by nature they are moved towards the centre, their connected forms prevent

them from moving so. It is because of their forms, therefore, that they remain stationary about the centre. It is also conceivable that the heavens should possess levity, and that levity could not cause them, nevertheless, to move away from the centre, because motion could only take place when the parts of the heavens became separated from each other, or when a vacuum existed outside the heavens so that the parts either moved or became fixed in the vacuum. Because it has been ascertained and proven that the dispersing of the parts of the heavens is impossible and the existence of a vacuum absurd, it follows that the heavens are themselves a hot fire assembled and confined in a place from which departure is impossible. Consequently, the levity or gravity of the heavens is not dependent upon the absurd ideas of (Aristotle).

As to only circular motion being possible for the heavens, it may be that the heavens are by essence and nature the source of rectilinear motion, and only by force and accident the source of circular motion, as is the case with the stars, which move by nature from east to west, and by force from west to east.

The presence of each element in its natural place is not certain. The natural place of gravity i.e., the downward direction, is at the circumference. Yet the centre is nothing but a point; and a part of the earth, no matter how small we conceive it to be, cannot fit at the centre. As for the circumference, neither can it hold any body in such a way that a light body may ascend to it, since it is an imagined surface area. Furthermore, if we allow water to flow freely, taking away any obstacles in its path, undoubtedly it will reach the centre, therefore, the assertion that the natural place of water is above the earth is without any basis. Consequently, there is no 'natural place' for any body. On such a basis he who says that the heavens are indeed heavy, but that it is their being attached that prevents their falling does not appear absurd.

Notwithstanding the incorrect premises of these medieval

scientists one cannot fail to admire the closely-argued logical assertions of al-Bīrūnī. Besides this, al-Bīrūnī's studies were so far-ranged that he was able to identify the source of Ibn Sīnā's information and was, therefore, able to countercheck his adversary's reply. One such example was his query on the continuity and discontinuity of matter and space.

He asked, "Why has Aristotle rejected the assertion of the theologians that a body consists of indivisible parts, and why has he chosen instead the assertion of the philosophers that bodies are infinitely divisible, even though wickedness of the philosopher's belief is greater than the disgracefulness of the theologian's opinions? According to philosophers, who consider bodies to be connected and infinitely divisible, it is necessary that a rapidly moving body touch a preceding but more slowly moving body. The touching of a preceding body by a succeeding one is inevitable, if the succeeding body traverses the intermediate distance, but the traversing of that distance requires the traversing of its parts. Since the parts of that distance are finite in number, how can one imagine that the distance can be crossed? Therefore, no succeeding body can reach a preceding one. It is necessary to give an example to prove this point. If there is a definite distance assumed between the moon and the sun, and both bodies are moving at that distance, it should be impossible for the moon to reach the sun, even though the motion of the moon is much faster than that of the sun. However, such is not the case; by observation it is found that the moon does in fact overtake the sun, though such an event brings disgrace and shame upon those who subscribe to the view of infinite divisibility so well-known and well-established among the geometers. What happens to the philosophers is thus more disgraceful than what happens to the theologians. How then can one escape what has befallen these two groups?"²³⁰

In the face of this argument based on the practical and logical deductions and full of withering invective, Ibn Sīnā replied that, according to Aristotle, infinite division cannot always be performed actually, but may sometimes exist only potentially; al-Bīrūnī's criticism, however, applies only to division in actuality. Al-Bīrūnī countered it by tracing Ibn Sīnā's source of answer:

Abū 'Alī (Ibn Sīnā), has learnt this answer from Muḥammad ibn Zakariyyā al-Rāzī (Rhazes). Muḥammad ibn Zakariyyā has said, "If for each of these objects, i.e., parts of a body, there be two sides and a middle, division can be carried out indefinitely, which is impossible." When you say "actually", I do not understand the meaning of that expression. For no matter how finally you grind collyrite, you will never actually reach that part of which you speak, because the actual division will come to a halt before you reach it. In any case, potentiality remains in its place. Also, according to your view, it becomes necessary that the sides of the square be equal to its diagonal; if you deny it, you have opposed your own principles, or you may say that between the parts there is a separation; in this case I ask if the separation is greater or smaller than the indivisible parts.²³¹

On the question of refraction they also differed. Ibn Sīnā believed in the sun as composed of a fifth element, having neither fire nor heat. The latter was produced by refraction, for rays were not material or else it could not penetrate through the air as two elements could not combine. Al-Bīrūnī correctly believed that rays carry heat from the sun, and there was no sphere of fire below the moon's sphere. He also believed that rays could penetrate air and water. On the basis of his studies, al-Bīrūnī rejected Aristotle's observations on the possible elliptical shape of the heavens. Similarly he rightly rejected the peripatetic contention that vision is by emission of rays from the eyes and not from the objects.²³² However, Ibn Sīnā was correct in suggesting contraction as the basis of breaking of vessels due to solidification of water while al-Bīrūnī contended that it was due to the vessels' incapability to hold the contents.

The correspondence shows that al-Bīrūnī described the theorising philosophers and logicians. His practical genius did not allow him to subscribe to their views. Confidence in the correctness of his findings and in his vast studies made him adopt an arrogant style. He did not accept the scholars of Basrah and Baghdad such as Jāhiz and branded them as naive. Little wonder then that he

regarded Ibn Sīnā, seven years younger to him, as a young *fādil*.

وقد ذكرت ذلك في مواضع اخر اليق به من هذا الكتاب و
خاصة فيما جرى بيني وبين الفتى الفاضل ابى على الحسين
بن عبد الله بن سينا من المذكرات في هذا الباب -

[The discussions (were) held between me and my learned young (man) Abu'l Husayn bin 'Abd Allah and the latter agreed with me)].

The nature of the correspondence shows that al-Bīrūnī had analysed these problems thoroughly, had studied the available material on them and, therefore, enjoyed a scientific superiority in the exchanges, a fact which was later accepted by Ḥakīm Abū Al-Faraj Baghdādī.²³³

Ibn Sīnā did not reply to his senior challenger in the same vein and refused to carry on the acrimonious correspondence. He remonstrated against the derogatory style of al-Bīrūnī in the form of the replies by Abū 'Abd Allāh Ma'sūmī, one of his disciples, reminding him that a better language would have suited '*aql wa 'ilm*'.²³⁴

Such a harsh attitude on the part of al-Bīrūnī was in fact due to his intolerance of ignorance and lack of knowledge in others. Imām Ḥakīm Labībī, one of al-Bīrūnī's disciples added a gloss to one of the books by his teacher. He said that his master never illustrated his arguments in his books with examples for he wanted his readers to develop the habit of critical interpretation and a desire to strive for knowledge for its own sake. He did not care for those who lacked these qualities. However, this statement is true only in respect of his major works and writings. He was capable of coming down to the level of ordinary readers. He made the whole question of the sun's apparent revolving at the poles easily intelligible for Sultan Maḥmūd. At the same time his book on the introduction to astronomy written for the lady Rihānah is a masterpiece of simple elucidation in simple language. Another such book describing the difference in the duration of day and night on earth was written for Sultan Mas'ūd. The book won the Sultan's approbation.

No light is shed on the mutual relations between the two

rivals at the court of the Ma'mūnids of Khwārizm. Probably the good temperament of al-Bīrūnī and his 'silver and golden tongue' and the forbearance of Ibn Sīnā, which he had also shown in his earlier conflict, did not allow the rupture to grow into any serious conflict. But differences of opinion could have been there. In fact, al-Bīrūnī till the end of his life was doubtful about Ibn Sīnā's proficiency in astronomy. While conceding the theoretical correctness of Ibn Sīnā's method of measuring longitude, he doubted its practical aspect thinking that would not yield precise results.²³⁵ Thus it may be assumed that Khwārizm could have been the scene of a number of lively discussions between the two but as al-Bīrūnī was endowed with a ready wit he could have had the better of his opponent. No doubt there is no report of any serious conflict between the two. But as they seemed to have belonged to two political groups at Khwārizm, one that of al-Suhaylī and the other of al-Bīrūnī, possibility of some tension between their supporters cannot be ruled out.

Ibn Sīnā's main interest in the philosophy and philosophical aspects of mathematics was essentially as an organiser, encyclopaedist and philosopher. On the other hand al-Bīrūnī, one of the greatest scientists of all time was a champion of truth, and chose science and scholarship. However, both were basically men of science and some find it difficult to choose between them and regard them equal to each other while others regard al-Bīrūnī as endowed with a superior intellect.

MUHAMMAD IBN ZAKARIYYĀ AL-RĀZĪ (RHAZES)

Another noted person whose influence is manifest on the scholarship of his time was al-Rāzī (865–925 A.D.). His fame mainly rests on his medical works e.g., *al-Hāwī* (Continens), which al-Bīrūnī often quotes in the *Kitāb al-Saydanah*, treatises on smallpox and measles etc. His other contributions were in the field of chemistry where he introduced the division of substance into animal, vegetable and mineral categories.²³⁶ By many he is conceded to be a genius superior to Ibn Sīnā. Rāzī also wrote on philosophy, physics and ethics.²³⁷ As these writings were tinged

with anti-prophetic sentiment, they were seriously criticised and consequently did not survive. In the medical field he combined the Galenic theory with Hippocratic wisdom. He rejected the possibility of reconciling religion and philosophy. In the field of philosophy he championed Plato against Aristotle and admired Socrates. Therefore, both Ibn Sīnā, the last of the great peripatetic philosophers of Islam, and al-Bīrūnī studied him. He rejected the metaphysics of the *flāsifah* (philosophers). He has been called an atheist or Voltaire of Islam. His teacher was Īrān Shahrī.

Al-Bīrūnī made a special study of al-Rāzī's works. He attributed to him one hundred and eighty four works. Rāzī's works helped in fashioning al-Bīrūnī's knowledge and interest in physics, the doctrines of Mānī etc. His anti-peripatetic attitude found a new champion in al-Bīrūnī. Rāzī's influence probably led al-Bīrūnī to study the works of Īrān Shahrī. Therefore, it may be said that Īrān Shahrī and Rāzī were greatly responsible in moulding al-Bīrūnī's flowering of thought. Īrān Shahrī helped him in studying the history and doctrines of different ancient religions such as Manichaeism. While studying Rāzī's works, al-Bīrūnī was led to search for and read *Safar al-Isrār*, a work by Mānī.²³⁸ However, it may be pointed out that al-Bīrūnī was not a blind follower of these scholars. He was an impartial critic and did not condone their errors as may be seen from his criticism of the problem of divisibility of atom as enunciated by Rāzī. He also criticised Rāzī for following Mānī's confused views.²³⁹

It was in the same critical spirit that al-Bīrūnī and his friends such as Abū Naṣr Maṣṣūr and Abū Sahl Maṣīḥī, studied and read all the extant material on various scientific disciplines. They discussed the works of former masters and tried to correct them. In the field of astronomy alone they studied al-Khwārizmī, al-Ḥabash, Abū al-Ḥasan, al-Faraghānī, Abū Ma'shar, al-Bīṭṭānī and a number of others. All their life was spent in study, research and revision of the learning and knowledge available to them.

Besides those scholars with whom he came into direct contact, or those whose works influenced him, there were others such as Ibn Yūnus and al-Haytham about whose work al-Bīrūnī appears to be ignorant.

ABŪ 'ALĪ AL-HASAN IBN AL-HAYTHAM (ALHAZEN)

Al-Haytham was born at Basrah (965 A.D.). He was invited by the Fātimids to Egypt and died in Cairo (1039 A.D.). As astronomer and a mathematician, he was the greatest Muslim physicist and one of the greatest students of optics of all times. His researches in catoptrics included the study of spherical and parabolic mirrors. His problem in optics deals with reflection from a spherical surface. The problem known as Al-hazen's problem is: From two points in the plane of a circle two lines are drawn and meet at a point of the circumference and make equal angles with the normal at that point. It leads to an equation of the fourth degree. Al-Haytham solved it by the aid of an hyperbola intersecting a circle.

In diaptics he applied the rectangle of velocities at the surface of refraction, and found that the ratio between the angle of incidence and refraction does not remain constant; he also studied the magnifying powers of a lens.

In atmospheric phenomena he tried to measure the height of the atmosphere from the fact that twilight only ceases or begins when the sun is 19° below the horizon. He gave a better description of human eye and vision.²⁴⁰

ABŪ AL-HASAN 'ALĪ IBN SA'ĪD 'ABD AL-RAHMĀN
IBN AHMAD IBN YŪNUS (OR IBN UNUS)

He was one of the greatest Muslim astronomers and died in Cairo in 1009 A.D. Provided with a well-equipped observatory and asked by the Fātimid Caliph al-'Azīz, he started work for improved astronomical studies. However, he could only complete it in 1007 A.D. in the reign of the next Caliph al-Hakam and, therefore, designated it after him as *Al-Zij al-Kabīr al-Hakīmī* (the Hakemite Tables).²⁴¹ His contributions to trigonometry, though less important than those of Abū al-Wafā were considerable. He applied orthogonal projections to problems of spherical astronomy. He introduced the prosthapheretical formula which was indispensable before the invention of logarithm viz. equivalent of $\cos \alpha \cos \beta = \frac{1}{2} \cos (\alpha - \beta)$ and the approximate value of $\sin 1^\circ = 1/3.8/9 \sin (9/8)^\circ$

These were not the only sources of influence on al-Bīrūnī. There were others whose association helped him in acquiring knowledge, and in writing some of his books. Some of these persons were reigning monarchs such as Shams al-Ma'ali Washmagir Qabus, Sultan Mas'ud of Ghaznah and his son and successor Mawdud. However, al-Bīrūnī notwithstanding the fact that he accepted the need for royal patronage, wrote a number of books for various persons.²⁴³

Among these was a lady Rayhanah who also hailed from Khwarizm (or Kath) and for whom al-Bīrūnī wrote the celebrated *Kitab al-Tafhim* (Elements of Astronomy). In this book, keeping in mind the intellectual standard of the lady the master adopted a very simple and plain style viz., in the form of questions and answers profusely illustrated, and leaving out complicated discussions in contrast to his great works. Unfortunately nothing much is known about the lady and her relationship to al-Bīrūnī.

He wrote another book on elements of astronomy called the *Kitab Maqalid ilm ilahiyah ta bahadd shafi basit al-Kurh* for Asfahabad Jilijan Marzuban bin Rustum about whom also little is known.²⁴⁴

Another book of the same style and topic known as *Maftah ilm Hai'yat* was written for one Qadi Abū al-Qasim al-'Amri.

A number of books were indited on the request of scholars or answers to their queries. Among these Abū al-Hasan Musafir was instrumental for the writing of three books:

- a) *Tahdhīb fuṣūl al-Farḡhānī* was probably a commentary with corrections on *Kitab Fuṣūl al-Farḡhānī*, a book on astronomy.
- b) The *Kitab Afrād al-Maqāl fī amar al-azlāl*, dealt with *misāhat*, the science of measurement of earth.
- c) The *Kitab iti'māl dawā'ir al-samāwāt al-astakhraj marākaz al buyūl*, explained the use of *dawā'ir al-samāwāt* for finding out the centres of the sections (*Khānah*) of the stars.

For a Jurjani astronomer, al-Bīrūnī wrote a *risalah*, *Maqalah fī Tala' qubbat al-ard wa halat al-thawabit al-'arud* and for another

scholar he wrote *Ikhtilāf al-aqāwīl al-astakhrāj al-tahāwil*. He also wrote answers to the queries sent by the astronomers of India and to the ten questions posed by the scholars of Kashmir. However, history should acknowledge the debt of Abd al-Mu'min ibn 'Alī Nūḥ al-Ṭiflīsī who encouraged al-Bīrūnī, to record what he knew about the Hindus.²⁴⁵

ABŪ SAHL 'ISĀ IBN YAHYĀ AL-MASĪHĪ AL-JURJĀNĪ

Abū Sahl Masīhī was not credited for being instrumental in encouraging al-Bīrūnī's authorship. But together with al-Bīrūnī, al-Kḥummār, Ibn Sīnā etc., he was a member of the group of learned persons at the Khwārizmian court.²⁴⁶ He was a teacher of Ibn Sīnā and wrote an encyclopaedic work on medicine besides a number of small clinical treatises. According to *Chahār-Maqālah*'s popular version he along with Ibn Sīnā refused to go to the court of Maḥmūd, but died of thirst after having lost his way in a desert. It seems that he left with Ibn Sīnā long before Maḥmūd's attack. He was on very good terms with al-Bīrūnī and he could have been responsible in bringing some sort of accommodation and rapprochement between al-Bīrūnī and Ibn Sīnā. The nature of the close relations between al-Bīrūnī and al-Masīhī and their scholarly discussions may be seen from the list of the twelve books written by Abū Sahl in the name of his friend.²⁴⁷ He might have helped al-Bīrūnī in his Greek studies. Their common interests seem to be in the field of *hindsah* (numbers), motion, movement of earth, astronomy, spots of the sun, causes of the coldest days of winter, the 'First Cause' in metaphysics, script, etiquettes for the companions of kings etc. Abū Sahl probably died in 999–1000 A.D.

CHAPTER V

AL-BĪRŪNĪ AS AN ASTRONOMER

Al-Bīrūnī's academic interests and activities encompassed a wide variety of subjects ranging from the abstract theories of philosophy to the practical sciences of mathematics, geography, physics and astronomy. However, his main field of study was astronomy:

ثم كنت متعلقا بطرف من اطراف العلم الرياضى متمسكا به
متناسبا اليه لم تعده همى مذكنت فأثرت خدمة خزانته
المعمورة الموسومة بالحكمة بقانون صناعة التنجيم -

[As I belong to a branch of mathematics, and since my coming into this world, I have been holding it strongly and have been known by it and my intention never exceeded it; therefore I, for his (Mas'ūd's) treasury which is known as *hikmat* as a service (on my part), have preferred to write the *qānūn* (laws) of *Ṣina'at al-tanjīm* (the art of astronomy)].²⁴⁸

However, al-Bīrūnī's age was characterized by orthodox reaction, as has already been pointed out in the introduction. There were people who regarded astronomy as heresy.²⁴⁹ This prejudice was similar to people's opposition to logic on the plea that its terminology belonged to the pagan Greek literature and language, although the adoption of Greek terms was mainly the fault of the translators.²⁵⁰ In much the same way there were people who ignored geography as something without any utility, though the *Qur'ān* is full of episodes of travels and adventures e.g., of Prophet Abraham's journey from Ur, of Dhu'al Qarnayn, of Moses from Egypt and the *hijrah* of the Prophet of Islam (peace be on him). Another illogical prejudice was shown against Arabic although it was

the language of the Holy Book and its vast vocabulary made it the most suitably possible vehicle for scientific studies.

After analysing these unscientific tendencies, al-Bīrūnī produced convincing arguments for establishing the claims of physical sciences. He reminded the opponents of astronomy that God asks people to contemplate on the marvels of the earth and heavens, believing that all the phenomena of nature reveal truth of the highest import:²⁵¹

الذين يذكرون الله قيا ما وقعودا على جنوبهم ويتفكرون
في خلق السموات والارض ربنا ما خلقت هذا باطلا -
(القرآن ٣: ١٩١)

[Such as remember Allah, standing, sitting and reclining and consider the creation of the heavens and the earth, (and say): O Lord; Thou createdst not this in vain].

He provided illustrations of the daily usage of mathematical and astronomical knowledge. It helped in ascertaining the influences of the sun and the moon in the form of what we know as the seasons and tides. Knowledge of stars and their position are of considerable help in setting directions during travels and journeys. Similarly it is very helpful in ascertaining the correct directions of *qiblah* and the timings of prayers and the longitudes and latitudes of cities. In this way astronomy was shown by him to be a useful, functional science and in conformity with the injunctions of Islam.²⁵²

As astronomy is inter-related with a number of other sciences such as cosmogony, mathematics and geography, al-Bīrūnī's magnum opus, the *Qānūn al-Mas'ūdī* is modelled on the pattern of the *Almagest* of Ptolemy. To know the broad range of his mind would require a deep study of his treatment of those subjects which is neither warranted nor feasible here due to limitations of space and time. However, his astronomical theories are of significant bearing and will therefore be discussed in this chapter.

THEORY OF THE UNIVERSE

Al-Bīrūnī considered the universe to be situated on the outermost surface of a limited sphere. At the same time he did not accept the concept of the universal gravitation as an actual force as

being altogether opposed to experience. He also asserted that "when a part of a mass at rest moves from one part to the other, it moves in a straight line, but, on the other hand, its movement round another body at rest is of a circular nature and represents a movement round a fixed point like the earth's centre. However, the neighbourhood of the sun caused the planets to describe ellipses."²⁵³

COSMOGENY

Although the *Qānūn-al-Mas'ūdī* does not discuss the origin of the Universe, a detailed study was made by al-Bīrūnī in *al-Taḥdīd*. He rejects the traditional view that the world is eternal. He was opposed to Aristotle's theory of the Moving Cause because the Aristotelian concept does not fit in with a dynamic and changing universe. This point was brought home by Ibn Ruṣḥd. He asserted that repeated changes in the formation of earth as proved by the embedded and petrified fauna and flora conclusively disprove the eternity of the world. He compiled the various cosmogenies current in his age and completed the work of 'Abd al-Malik al-Ṭayyib al-Bustī in one hundred pages.

Earlier discussions have shown al-Bīrūnī's severe criticism of Aristotle's theories. However, it does not mean that al-Bīrūnī was an avowed anti-peripatetic. He, like a true scientist and scholar, was ready to criticise and reject what his experiments showed him to be false or incorrect. He supports Aristotle in surmising that in its earlier stages the earth was probably in a fluid state.²⁵⁴

GEOCENTRIC THEORY

The geocentric and heliocentric controversy engaged the mind of al-Bīrūnī and his contemporaries. Some modern scholars have criticised al-Bīrūnī for accepting the geocentric theory while Rāzī, Ibn Sīnā and others subscribed to the opposite view.²⁵⁵ However, in that age when the telescope and modern precision instruments were lacking, it was difficult to arrive at any definite conclusion. Al-Bīrūnī, whose ideas on this point coincided with those of his

teacher Abū Nasr Maṣṣūr, was not ready to accept a new theory without definite scientific evidence.²⁵⁶ Until an alternative theory was conclusively proved, it was but logical to believe and accept the older theory or explanation. The objections by certain Arab scholars of XIVth century, accepted by Barthold and other orientalisists, ignore the actual position adopted by al-Bīrūnī. While discussing and commending the astrolabe, al-Zawraqi, prepared by Abū Sa'īd al-Sijzī, who constructed it on the heliocentric notion, al-Bīrūnī frankly admitted his inability to arrive at a definite conclusion. He knew that it would be difficult for the geometricians and the astronomers to contradict the heliocentric theory. He also knew that for the laws governing the movement itself be it of the heavens or of earth, a belief in one theory or the other did not make any difference. Al-Bīrūnī wrote a separate book, the *Kitāb al-Taṭbīq fī Taḥqīq ḥarkatah al-Shams* on the movement of the sun.²⁵⁷

CALENDARS AND CHRONOLOGY

Having discussed the six basic problems relating to the sphericity of the heavens and earth, the geocentric theory, the nature of the Eastern and Western notions in the heavens, al-Bīrūnī goes on to define the imaginary circles and signs so often referred to in astronomy and geography, i.e., the poles, the equator, longitudes and latitudes, obliquity and the signs of the zodiac.

However, as an astronomer and chronicler, al-Bīrūnī had to devote special attention to the study of time and dates. His own interest compelled him to look into the calendars of different nations, imperial enquiries about differences in the time of day and night in different regions and the continued long day at the poles and problems of finding the correct timings of prayers led him to conduct researches over a long period from the writing of the *Chronology* to *Qānūn al-Mas'ūdī*. He wrote a number of other books as well. A small *risālah* was written about day and night which also proved the duration of a year long day at the pole. He devised a measure for working out hours and periods of day and wrote a book on it called *Ta'bīr al-mayzān al-Taqdīr al-azmān*. Al-Bīrūnī also compiled a small treatise on the Indian methods

determining divisions of time. His *Tanqīh al-Tawārīkh* pertains to the study and research on dates. *Tasawwar amr al-Fajr wa al-Shafaq fi Jahat al-Gharb wa al-Sharq* explained and discussed the appearance of dawn. He also wrote *Lawāzim al-Harkatayn* in deference to Mas'ūd's queries and another book explaining differences in day and night and the day's duration on the pole.²⁵⁸ His teacher Abū Naṣr Maṣṣūr also wrote his risālah, *Dawā'ir allati taḥad al-Sā'at azmāniyah* for working out hours and periods.

Qānūn al-Mas'ūdī among the last books of the great master, also discussed these problems in detail. As in the *Chronology*, it deals with day and night, lunar and solar months and years, a detailed account of the different calendars, particularly new and additional information about the Indian ones; conversion of *Sakkala*, *Yazdgird* and *Alexandrian*, the most commonly used calendars into *Hijra*. Considerable interesting and useful information can be gleaned from these studies.²⁵⁹

He found, for example, that Zoroaster lived 267 years before Alexander and 1,218 years before Yazdgird. The *Alexandrian* era commenced ten years after Alexander's death. The *Sakkala* era of India started 587 years before the *Gupta Kāla* on which the *Khanda-khāndyaka* was based. He also found that exactly 3,472 days elapsed between the date of *Hijrah* and Yazdgird, the last of the Sassanid.²⁶⁰ The ancient Arabs that learnt intercalation of calendar from the Jews of Yathrib (Medina), 200 years before the Prophet (peace be on him), had fixed seasons and dates for the pilgrimage, festivals and market days. The pilgrimage used to fall in Sha'bān. The Prophet (peace be on him) did not like it and did not perform it. However, after the conquest of Mecca he restored it to its ancient position.²⁶¹ The Prophet (peace be on him) was born on 8th Rabi' al-Awwal and nine years, eleven months and twenty days elapsed between his migration to Medina and his death.²⁶² He knew that the Jews and Christians differed on the date of Adam and stated that it was difficult to assign any definite date to such distant events. At the same time he put forward the hypothesis of long ages or eras for the present formation of the earth. An idea of al-Bīrūnī's grasp over the complicated computation may be formed from his description and criticism of the methods of

determining different times of the day.

The first method refers to the use of a staff until its shadow be at the shortest and full, north and south. Al-Bīrūnī finds this system defective, for the sun for a very short time before and after mid-day does not change its elevation. It also means that the facing of the shadow changes at the high angle while the change will not be observed because of the length of the shade.

The second method uses triangles. A circle should be drawn around the staff equal to half of its diameter in length. The observation should be made when the shadow touches the circumference, it is *Zuhr* and that facing of shadow will be the required facing. However, at *Zuhr* there is a slow change in the length of shadow. It is also difficult to limit the touching of shadow and the circle. The third is an improved version of the second. In it the length of a shadow is reckoned when the sun is in east and west for the north and the south. But it is a different and very rare situation. The sun is never in that position except during a specific period of the year.

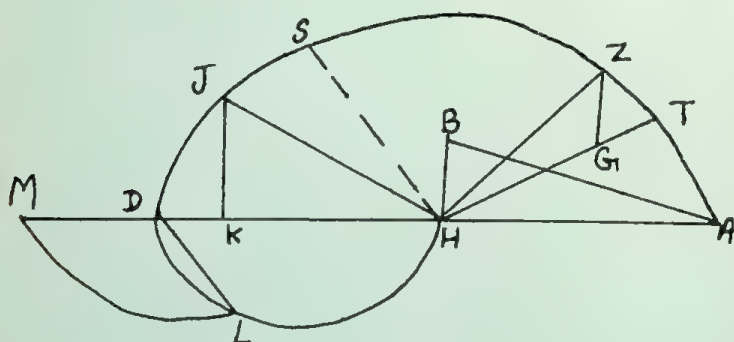
The next method and the fourth one is to picture the facing of shadow at sunrise and sunset and reckoning the angle between it and eastern line or western line. But it requires an empty space free from any obstruction in the observation of the sun when it is on the horizon. The fifth method requires the selection of a fixed elevation of the sun, the length of shadow and its facing in proportion to the line from north to south is reckoned. When the sun attains this elevation the shadow is observed on the line, north to south.

Al-Bīrūnī also described the Indian method of determining time by the so-called the Indian Circle. One is to circumscribe a circle round the staff, its diameter being equal to the length of the staff. One reason for choosing this length is that the side of shadow enters and goes off the circle every day in the axis of the year. Then it is confined to the circumference of the circle, the point of entry by the side of the shadow in the morning and going out at *Zuhr*, so the diameter of the circle becomes intermediary between the north and the south. This is because the length of the shadow in the morning is equal to that after *Zuhr*, since the elevation is equal. It seems that their distances from the north and the south are equal and so the required facing is there.

This method is an improvement on the previous ones but it ignores the change of the earth on its orbit round the sun between two observations. Therefore, the point of entry and retreat of the shadow will not be the middle of north and south.

Having critically examined all the methods al-Bīrūnī proceeded to give a more scientific and correct method using geometrical solution. His method enables one to make observations at any time and the required facing with the help of geometrical figures:

When HA is the length of the shadow and the movement facing it is MA. In the first figure we draw HB perpendicular on it and equal in length to the staff. Then we take two angles AHT and THZ equal for the breadth of the space (90-B) in succession where B faces the sun at the time of its rising on that day and that is well known.



Then we make ZG perpendicular on HT and HJ parallel to the straight line AH and JDH and its diameter JH and after that we assume HD and draw half circle DLH and JH parallel to straight line ZG then we take KM equal to HD to straight line HJ and after that we have DL in the half circle DLH equal to the straight line DM and we draw HS parallel to it and that is the required facing of north and south.

This method of al-Bīrūnī is quite complicated. Al-Bīrūnī like the Indians forgot the changes in the position of the earth in its orbit round the sun at the two moments of its rising and its observation.²⁶³ Besides the above mentioned methods of finding the correct timings of *zuhr*, dawn and sunset, he also worked but

calculations to find out what part of the day had passed since the rising of the sun by observing its elevation, by observing the falling line from north to south. In between he also discussed fixing of time in the night by observing the stars.

THE SUN

The next important topic is al-Bīrūnī's study of the sun and allied matters.

Physical Nature of the Sun: Al-Bīrūnī never regarded himself to be a physicist and often passed over problems pertaining to physics as outside his domain of study. Nevertheless, he was conversant with contemporary studies in physics and sometimes offered some original contributions. His study of the physical nature of the sun falls under this category. He categorically rejected the mythical notions about the sun's nature which were a part of the Greek legacy. According to him the sun is a fiery body for the solar eruptions (or prominences) noticeable during the total eclipses, were just like the flames arising in the atmosphere around some burning body.

The Annual Movement: Al-Bīrūnī believed in the geocentric theory and regarded the sun as moving around the earth. He was, however, aware of the heliocentric point of view as well. He thought that the slow and fast movements of the sun pre-supposed an orbit. The medial fastness was the result of the annual length which was the intervening period between the entry of the sun in a fixed point of orbit and its return to it.²⁶⁴

Length of the Solar Year (Tropical): While studying the length of the solar year, al-Bīrūnī noticed variations and discrepancies in the ancient knowledge. He reported at least four different conclusions, i.e., 365.2426, 365.2421, 365.2398 and 365.248 days. After calculations and observations he preferred the figure of 365.2422 days. Hipparchus and Ptolemy had accepted the length of the years as 365 days, 5 hours and 56 minutes. In the reign of al-Mam'ūn an iron pillar was erected at Dair Marwān, but as it shrank due to cold nights, errors crept up in computations. Al-Bīrūnī worked out 365 days, 5 hours and 46 minutes. The Jalālī Calendar also had

365 days, 5 hours and 49 minutes. Al-Bīrūnī's figure was 365 days, 5 hours and 46 minutes. It compares favourably with the modern estimate of 365 days, 5 hours, 48', 47½'.²⁶⁵

Determination of the Motion of the Sun's Apogee and Ascensionism: The Greek writers, particularly Ptolemy and Hipparchus believed that the annual distance between the sun and the earth to be firm and, that therefore, their positions were firm. The researches conducted by the Muslim scholars showed that it moved further east. The findings of the Muslim astronomers such as Khālīd al-Marwazī, 'Alī b. 'Isā al-Harrānī, Sind bin 'Alī Mūsā, Abū al-Wafā, al-Battānī, al-Khujandī were verified by al-Bīrūnī repeatedly at Khwārizm and Jūrjānia.²⁶⁶

However, in the beginning al-Bīrūnī agreed with al-Battānī that the apogee moved one degree in sixty-six years. But after his own observations and while writing the *Qānūn* he modified and improved his calculations. He worked out the movements of the apogee as one degree in more than $70\frac{1}{3}$ years, and O^O, O^I, 7^{II}; 44^{III}, 54^{IV} in a single day.²⁶⁷ Al-Bīrūnī was nearer the modern figures of 52.2 every year and one degree in 72 years.

Distance of the Sun from the Earth: Al-Bīrūnī had his doubts about Ptolemy's view that distance of the sun from the earth is 286 times the latter's circumference. His argument was that Ptolemy based his claim on total eclipses but disregarded annular eclipses which implied larger distances. Incidentally, al-Bīrūnī was unable to observe a total eclipse. Therefore, he could not verify the findings of Ptolemy, a fact which he frankly admits, that measurements of the moon's distance from the earth was possible, but he found the sun immeasurable by the instruments of that age and its distance remained an object for conjecture.²⁶⁸

Eclipses: In the eighth *maqālah* of the *Qānūn*, al-Bīrūnī presented a masterly exposition of both the solar as well as the lunar eclipses, specially the section dealing with *al-kusūfīn* (the images of the eclipses) which pass on the faces of the sun and the moon without affecting their body. He referred in his letter to a book on the two united and equal axes.²⁶⁹ This topic so well known in India was not known to Muslim astronomers.

Obliquity of the Ecliptic: Al-Bīrūnī described the obliquity of

the eclipse as the angle formed by زاوية تقاطع معدل النهار مع البروج وهو الميل الأعظم (the intersection of the celestial equator and the ecliptic). He found the measurements of the ancients differing from those of the Ma'mūnid and other Muslim astronomers. Earlier Greek, Indian and Chinese astronomers found it to be of 24° . Later on Eratosthenes, Hipparchus and Ptolemy estimated it to be $23^{\circ} 51', 20''$. The Ma'mūnid astronomers found the minutes ranging from 35 to 32. Al-Bīrūnī himself took measurements at Khwārizm and Ghaznah and found the figure of $23^{\circ} 35'$ to be correct.²⁷⁰ He was unable to discern the real reason behind these variations. Later al-Zarqālī and Tūsī explained it as occurring due to the decreasing angle of the ecliptic.

In this respect al-Bīrūnī commends the sextant *Sudus al-Fakhri* built by al-Khujandī at Rayy. It was built on the hill of Tabarak near Rayy in Khurasan. It consisted of two walls separated by seven cubits, parallel to the meridian line, supporting an arch. The circle with its centre on the ground was divided into degree and minutes, every one of which was further divided into 10 seconds. The sun's rays passed through the aperture and fell on the ground on the central point of the circle parallel to the meridian line. Unfortunately the aperture slid down and repairs could not correct its position, thereby affecting the measurements which came to $23^{\circ} 59' 25'' - 54''$.²⁷¹ Al-Bīrūnī himself carried on prolonged measurement. He was consumed by an extreme urge to find the correct figure, and he took the first measurements in 384 A.H. (994 A.D.) at Khwārizm with a circle having a diameter of 15 cubits. Later he took measurements in 1016 A.D. at Jurjāniya. However, his political association with 'Abbās b. Ma'mūn left him little time to carry on his studies. His next measurements were taken at Ghaznah in 1019 and 1025 A.D.²⁷²

He had commenced his studies of the ecliptic with its relation to the sun's summer and winter solstices and compared his own findings with the more ancient and older studies. He suggested a large circle for better divisions. Thus with characteristically thorough and repeated research and experimentation he reached the value of $23^{\circ} 35'$ which according to Nallino exceeded to a nominal extent of 0.57 only.

Dawn and Sunset: He discussed the reasons and timings of dawn and twilight. Ibn al-Haytham states that at twilight time the sun is 10° below the horizon. Al-Bīrūnī found out that twilight (morning and evening) occurs when the sun is 18° below the horizon. Modern researchers have verified al-Bīrūnī's findings. He wrote *al-Lam'at* on this subject. Another book, *Taşawwur amar al-Fajr wa'al-Shafaq fi Jahati al-Gharb' wa al-Sharq* (about dawn and morning) was still incomplete in 1034–35 A.D.^{2 73}

THE MOON

Besides the sun the next important heavenly body was the moon. Its movements have formed an important part of astronomy.

Movements of the Moon: The moon does not move in a perfect circle. Its maximum and minimum distances differ appreciably. It changes its path and is variable. Its first irregularity was discovered by Hipparchus. Ptolemy discovered the second irregularity and explained it as an epicycle. Abū al-Wafā found out the third irregularity. Al-Bīrūnī stated that the moon returned to its former place in relation to fixed stars but minute differences occur and accumulate.^{2 74} Therefore, a constant watch spread over generations was required. He remarks, "The moon's movements, nay, those of all the moving bodies in the heavens are not ascertainable in a single attempt, as they vary from time to time. This method should go on *ad infinitum* and that is all that is required of an original worker in his field."^{2 75}

Lunar Month: He discussed the lunar month on a synodic basis, i.e., referring to its position, and return to it, in relation to the sun. Relying on the ancient observations, he found out that it consisted of $29\frac{1}{2}$ days and $29^{\circ} 31' 50'' 8''' 9^{IV} 20^V 13^{VI}$ to be more exact, or in the alternative $7^{IV} 10^V 9^{VI}$.^{2 76}

Anamolistic Daily Movements and the Mean: An anamolistic movement means the nearest point of approach to the sun (perihelion) and back to it. This movement consumes greater time than the moon's movement from one star to another.

Al-Battānī worked out the mean daily motion as $13^{\circ} 10' 35''$

and the anamolistic as $13^{\circ} 3' 54''$. Al-Bīrūnī took great pains in fixing the points of the moon's movements and made three consecutive observations in 1003 A.D. and 1004 A.D. with the most careful of precautions. وبالغت في تدقيقه وتحقيقه. His reading of the mean was $13^{\circ} 10^I 34^{II} 2^{III} 7^{IV} 17^V 8^{VI} 25^{VII} 27^{VIII} 25^{IX} 42^X$. His anamolistic reading was $13^{\circ} 3^I 13^{II} 54^{III} 8^{IV} 5^V 31^{VI} 32^{VII} 9^{VIII} 44^{IX} 42^X$. Al-Bīrūnī's mean values are the closest to the modern findings of $13^{\circ} 10^I 34^{II} 52^{III} 9^{IV} 2^{VII}$.

Obliquity of the Moon's Ecliptic: The Indian astronomers had determined the obliquity of the moon's ecliptic as $4\frac{1}{2}^{\circ}$ while Ptolemy had stated it to be 5° . The Ma'mūnid astronomers reported it to be of $4\frac{2}{3}^{\circ}$. In this field al-Bīrūnī admitted his inability to ascertain and check the truth. Nevertheless he accepted the value of Ptolemy which was more accurate.²⁷⁸

Diameter of the Moon and its Distance from the Earth: Al-Bīrūnī measured the longest distance and the shortest distance of the moon from the earth. They were $63^{\circ} 32' 40''$ and $31^{\circ} 55' 55''$ of the earth's diameter. However, he was not sure of the diameter of the moon and rejected al-Battānī's $33^{\circ} 33' 20''$ of the earth's diameter. For the moon appears larger when nearer to the earth and smaller when more distant. Its appearance diameter, therefore, varies relative to its distance from the earth.²⁷⁹ Nevertheless with this apparent variation he knew that the real diameter of the moon should be a constant value. Therefore, as in other cases, where he was unable to verify these figures, he accepted the correct one from the older astronomers. In this case he again followed Ptolemy and accepted his value of the moon's diameter as $31' 20''$ of the earth's diameter. Here again his scientific insight led him to choose the correct figure, for Ptolemy's value is nearer to the modern value of $31' 17''$.

He thought that the ratio between the shadow of the earth on the moon during a lunar eclipse was $2-3/5$ to 1.

The Tides: The great scientist was able to express with lucidity the rules governing tides and ebbs. He explained that the increase and decrease in the height of the ebbs and tides occurred in cycles on the basis of changes in the phases of the moon. He gives a very vivid description of the tide at Somnath and traces the latter's

etymology to the moon.²⁸⁰

Appearance of the New Moon: Since the *Hijri* calendar was based on lunar cycle, appearance of the new moon becomes important for the observance of holy days. Al-Bīrūnī also studied this problem. The Greeks had ignored it. However, the Muslim astronomers such as al-Fazārī, Ya'qūb al-Tāriq, al-Khwārizmī, Ḥabash al-Ḥasīb etc., had worked on it. Al-Bīrūnī found the appearance of a new moon an uncertain affair. In this respect he supported the findings of Ḥabash and followed them.²⁸¹

THE STARS

The Fixed Stars: Al-Bīrūnī knew that it was practically impossible to determine the number of bodies of various magnitudes even in a small portion of the sky. He was also aware of the limitations of the instruments of his age. Among the ancient astronomers, Hipparchus was the first to catalogue 1,000 stars. Ptolemy also worked on this basis. Among the Muslim astronomers, 'Abd al-Rahmān al-Ṣūfī made a specialised study of the stars. Al-Bīrūnī appreciated his work and relied upon him. He himself did some charting and made some minute corrections. Al-Bīrūnī adopted the Greek nomenclature of 48 figures and 12 constellations arranged on a belt. However, he did not regard himself competent enough to discuss their colours, for it was difficult to study the problem and all the discussions about it were mere surmises. About the nebulae he says: "In the skies we have some objects not resembling the stars in their roundness and light. They are white patches called the nebulae. Some of these are considered to be composed of clusters of the stars."²⁸²

He rejected Aristotle's contention that the Milky Way was under the sphere of the planets and correctly estimated it to belong to the 'highest sphere of the stars.'²⁸³ He also attacked Aristotle for believing that stars cause injury to sight and are responsible for sorrow and misfortune. This shows that he was basically rational in approach and did not attach any superstition to natural phenomena.

Eastern Movements of the Fixed Stars: Al-Bīrūnī thought that

these stars moved to the east on a central axis and parallel to the zodiac. Here again he knew that a study, spread over generations of this phenomenon, would be required to find some explanation. In 422 A.H. when he studied the stars he found them to have moved 13 degrees since the time of Ptolemy.²⁸⁴ Ptolemy believed that the stars move by one degree in one hundred years. The Muslim astronomers e.g., Ibn Yūnus, found the period to be of 66 years. Upto the writing of the *Kitāb al-Tafhīm* (1025 A.D.), al-Bīrūnī, following Ibn Yūnus, al-Battānī, supported the 66-year period.²⁸⁵ However, the Muslim astronomers including al-Bīrūnī were not satisfied. Ibn Yūnus and al-Bīrūnī both working independently of each other came to the conclusion that the movement of the stars occurred at the rate of one degree nearly every 70 years. Ibn Yūnus gave 70½ years while al-Bīrūnī found it to be 70⅓ years. Modern researchers show that al-Bīrūnī was nearer the truth, for the present calculation makes it 72 years.

Distance and Magnitude of the Stars: He believed that as there was no way to find out the parallel of the fixed stars it was impossible to determine their distance and magnitude. The Greeks thought that the stellar sphere was next to the most distant planet. Ptolemy regarded the distance as 19,666 times the earth's radius. Mars was accepted as one half of the sun's diameter. Al-Bīrūnī had given Indian figures and himself followed al-Ṣūfī in the magnitude of the stars.²⁸⁶

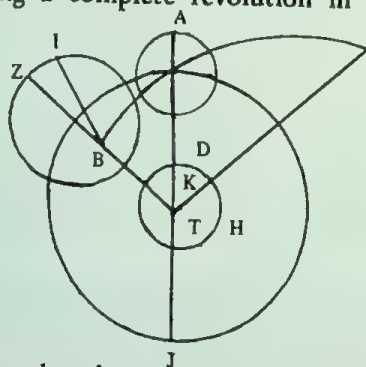
The Planets: In the study of the planets, al-Bīrūnī regarded Ptolemy's studies as the most perfect and inspired theory and, therefore, followed him. However, here also his practical studies and observations enabled him to add something to the ancient knowledge. He found the eastern movements of their apogee similar to that of the sun, i.e., one degree in 70⅓ years instead of 100 years period of Ptolemy.

Al-Bīrūnī doubted the accepted order of the planets that placed the sun between the moon and the two inferior planets, Venus and Mercury. He contended that it was possible that the sun is below all the other planets except the moon or on the other hand there could be some planets between the sun and the moon.²⁸⁷

Planetary Motion: He made a special study of the planetary

motions and combined the eccentric and the epicyclic systems into one system and tried to explain the complex planetary motions in terms of the circles of the Pythagoreans while at the same time he transformed the abstract geometrical figures of the Greeks into concrete spheres. In this way he was trying to preserve the idea of celestial harmony which had deeply influenced the Greek gnostics, specially the Pythagoreans.²⁸⁸ His treatment of the whole phenomenon is masterly as may be seen from the following extract.²⁸⁹

In order to form a conception of (the motion of) Mercury in terms of what it is like, we place the deferent upon the centre D, find the diameter ADHJ and divide DA into three equal parts by KT. We draw the circle being the deferent for the centre of the deferent circle. We say that the motion of Mercury is like that of the moon in that it (the deferent) has no permanent position but moves discontinuously by reason of the motion of its centre upon the circumference of the circle DHT, thus making a complete revolution in one year. (See Figure below).



Let us suppose that the centre of the epicycle is at A, when the centre of the deferent is at D. Then, as the centre moves through HD, the location of the deferent goes through MB. The centre of the epicycle moves about it (the deferent) continuously in a motion equal to its motion, so that they both make their revolution in the same period of time. During this time, while the centre of the deferent has gone through the arc DH, the centre of the epicycle has reached point B. It is clear that it reaches the apogee M when line KM coincides with line KH; which even occurs in half a year. To reach the perigee,

half of each half of AJ and JA is needed, so that the centre of the epicycle of the moon reaches the apogee of the deference in twice the ratio. The epicyclic motion of Mercury, however, is not at the middle of the centre of the deferent, but rather at point T, which is between points K and H.

We find the line TBZ and HB so that the mean is at Z and the point of vision at T. In order for the above mentioned motions to be equal, angles DKH and ATB must be equal. These two angles are the mean longitude, the angle AHB is the average longitude and the angle IBM, the adjustment of the longitude, more specifically the angle to be shared between them (the above angles). The point T, which is to keep the orbit of the Mercury even, is located between H, the centre of the heaven of the signs of the Zodiac (the heaven between fixed stars), and K, the centre of the (circle which is itself the) deferent for the centre of the deferent circle, just as the centre of the deferent for the four planets (Mars, Jupiter, Saturn and Venus) is located between H, the centre of heavens of the signs of the zodiac, and the point where the orbit is even.

From what has been stated, it should have become clear from the existence of this characteristic motion of the planets with regard to the motion of the sun, that the centre of the epicycle of each one of the inferior planets accompanies the sun, and that they (the planets) cannot move farther away from the sun, in any direction, than the radius of their epicycles. It has also become clear that the motion of each of the upper planets is about its epicycle and that of the sun so that this motion forces their constant immersion (of these planets) behind the apex (the disappearance of the superior planets because of their nearness to the sun). It is possible for the planet to be located at any spherical dimension with respect to the sun, because of the closeness of the motion of the centre of the epicycle to the motion of the sun, until it reaches the sun, passes it by and then returns towards it. It is this motion (of the planets) in the heavens that brings about the harmony of the cosmos, without its sustainer being evident.

This motion appears to be accidental, because of our own

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vision of it. And it is for this reason that if it were to happen (by accident) that the centre of the heaven of the apogee of the sun Z were to be placed upon a line crossing H, the centre of the heavens of the signs of the zodiac, and the point of the evenness of the orbit, and then the centre of the epicycle were to be placed at A (the apogee) or J (the perigee), the planet would become immersed at the apex K upon reaching the line which is the limit of the opposition of the mean sun with regard to it. Likewise, for one of the lower planets, the point M would become the place of immersion, while for one of the upper planets it would be the place of opposition to the position of the mean sun. The apogee of the sun, however, does not coincide with the apogee of any of the planets.

ANWĀ'

Anwā' is the plural of *Nau* which initially concerned the rains. The Arabs connected the rains with the mansions of the moon but gradually it became related to other atmospheric phenomena such as winds, moisture, heat and cold which were deemed to be influenced by the stars. The Indians had their own system and the Muslims combined this with the ancient lore of the Arab and compiled annual calendars forecasting meteorological, agricultural and even medico-hygienic developments. In fact, the Muslims may be credited with the development of the comprehensive meteorological system. Al-Bīrūnī studied all such information which was based on long observation, general experience and popular ideas of the past but found them lacking in universality. They varied from place to place. The least which he could say scientifically was that they appeared to be related to the sun's movements in the zodiac.²⁹⁰

THEORY AND PRACTICE OF ASTROLOGY

Popular tradition has acclaimed al-Bīrūnī as a great astrologer. This is probably due to the fact that in his age astrology and astronomy went hand in hand. The Iranian, the Greek and the Indian knowledge of astrology passed on to the Muslims who combined it with their knowledge of spherical trigonometry and mathematics. Al-Bīrūnī also studied this aspect of the stars and the planets. Half of his *Kitāb al-Tafhīm* deals with astrology. His

Tahmīd al-Muqtadar discusses *mamarr* (i.e., passing of one planet over the other). In *al-Hind (India)* he deals with the Indian astrology. He also wrote *Kitāb al-Tanbīh alī Šna'at al-Tamwīh* warning people against its malpractices.

However, popular tradition credited him with miraculous powers of foretelling. *Chahār-Maqālah* describes him as an astrologer. It relates the story that once Maḥmūd tested al-Bīrūnī's command over astrology and asked him to foretell from which side he (the Sultan) would leave. Al-Bīrūnī wrote the answer on a paper. After sometime the Sultan asked a door to be cut in the eastern side and went out. On checking, al-Bīrūnī's forecast was found to coincide exactly with the Sultan's doing. At this the Sultan had him thrown out of the pavilion. He fell on a net and came down to the earth unharmed. When the Sultan asked him about his accident, al-Bīrūnī showed him the facts related in his daily forecasts for himself. At this the Sultan flew into a rage and ordered him to be imprisoned. Later he was released when Ḥasan Maymandī, the minister, finding the Sultan in good humour requested for his release.²⁹¹ The story is evidently spurious. It is not corroborated by any historical evidence, autobiographical or otherwise. Besides, al-Bīrūnī, a man of practical knowledge repeatedly asserted non-utility and unsoundness of astrology. The last section of his *Kitāb al-Taḥfīm* starts with this sentence.²⁹²

و نزدیک بیشتر مردمان احکام نجوم ثمره علمهای ریاضی است هر چند که اعتقاد ما
اندیش شهره و اندرین مناعت مانند اعتماد کمترین مردمان است۔

That is to say, thus he wants to associate himself with the minority which did not believe in astrology. In *Kitāb al-Taḥdīd* he vehemently attacked the system itself.²⁹³

فان صناعة الاحکام الاوهی اصولها و بضعف فروعها و اختلاف
قیاستها فیها علی الیقین۔

(The system of predictions in astrology rests on totally absurd principles, weak deductions, contradictory guesses and merest assumptions, opposed to certainties).

In a similar view he writes the opening passage of the last

This science (of astronomy) to which this book is devoted is absolutely self-sufficient in its own excellent principles. But the heart of those people, who cannot conceive of any joy except in the things that can save them from bodily pains and of any gain except in the worldly boons, are not attracted and are even inimical to it and its votaries. This was the reason that led the ancient thinkers to connect the events of the world with the astronomical propositions and thereby establish the influence of the heavenly bodies in a delusive manner, and thus devise the bases of governing the forecast of the future occurrences and persuade the people to accept astrology as the very print (of astronomical science). This those thinkers did to gain their following, knowing that masses are greedy to learn the means from where they can derive benefit, avoid harm, ward off disgrace and avert big calamities.

He had a personal experience of the inadequacy of astrology. In 422 A.H., he mentions that he had often asked astrologers to tell him his actual age. The astrologers hopelessly differed among themselves.²⁹⁵ Nevertheless he was an adept in the art of astrology. He wrote a number of books on the subject. He knew that the Muslims knew very little of Indian system and in astrology the Iranians and the Indians were pastmasters. Sachau had regarded this statement of al-Bīrūnī as too sweeping but it cannot be gainsaid that a number of non-Indian practices were mistakenly attributed to the Indians.²⁹⁶ In the *Qānūn* he tried to put forward the universal principles on which astrological knowledge was based. He discussed the 12 celestial domains, the juxtaposition with reference to the signs of the zodiac, the contiguity of the planets in their longitudes and latitudes, horoscopes, the ascension and declension of the planets and their passage over one another etc. He presented a masterly exposition in the 10th *maqālah*. For example, he discussed the *qirānāt* (the conjunction of the planets). He described the three conjunctions *al-asfar* (the small) which was 20 years duration, *al-aswat* (the middle) was 240 years and *al-āzam* (the large) was 960 years. He warned against astrologers' love of twelve.²⁹⁷

He also discussed the millennia and other astrological periods. The beliefs of the Iranians and the Indians about the age of previous millennia, was unacceptable to him. He rejected their contention that conjunction of all the heavenly bodies preceded the creation of the world and also all the subsequent events in this world. In astrological matters he remained content with the narration of the Iranian and Indian beliefs. In fact, whatever of Indian astrology or other sciences he wrote in *India* or in the *Qānūn* was in the nature of a review of their system and beliefs.²⁹⁸ A greater exposition of Indian astrology was attempted in *Jawāmi' al-Mujud al-Khwātir al-Hunūd fī Hisāb al-Tanjīm Jā'tam minha fī* which is unfortunately no longer extant.

Al-Bīrūnī had found the Greeks more exact in their sciences and observations. The Indians, however, were better equipped in solar and lunar studies and the eclipses. What he basically aimed at was the exposition of the scientific method backed by firm belief in natural laws. He insisted on continuous observation, collection of reliable data and successful application of all these principles.

CHAPTER VI

AL-BĪRŪNĪ AS A SCIENTIST

Mathematics was regarded by the medieval scholars as a "gateway leading from sensible to intelligible world". In accordance with the Pythagorean interpretation so popular with the Muslim scholars numbers were regarded as an "ontological aspect of unity". In such a form they expressed unity in multiplicity. For this reason mathematics occupied a very important position in medieval Muslim studies and the Muslims were always attracted towards a subject which would help them scale nobler spheres.²⁹⁹

Though al-Bīrūnī dedicated himself to astronomy only, nevertheless he excelled also in mathematics. In that age mathematics consisted of arithmetic, geometry, physics and music.³⁰⁰ Algebra was also added to this list after the age of al-Khwarizmī. The Muslim applied the principles of spherical trigonometry to astronomy. Therefore, an expert astronomer had to cultivate the allied branches of mathematics. Al-Bīrūnī had command over geometry and arithmetic and used algebra expertly. He was also interested in physics. However, he does not seem to have any interest in music. None of the titles of his works which have come down to us bear any reference to that art. In his *India* also he discussed Indian beliefs, Hindu literature, grammar, meter, chess etc., but ignored Indian music completely. On the other hand in poetry, and in the *Kitāb al-Saydanah* he quotes verses from notable Arabic poets, giving mostly without fail their metrical arrangement.

SPHERICAL TRIGONOMETRY

Al-Bīrūnī wrote *Kitāb Maqālīd 'ilm al-hai'yah ta Yahdath fi*

basit al-Kurah for Asfahbad Jilijān Marzbān bin Rustum. Nizām al-Mulk Tūsī spoke highly of the book which is unfortunately lost to the posterity.³⁰¹ With this great command over language and subject matter it could have been a work equal to the *Kitāb al-Tafhīm* of astronomy which is lucid in style, profusely illustrated and free from difficult terminology.

When the great scientist reached the age of sixty, some of his works still remained to be completed. One such manuscript was entitled *Jāmi' al-Tarq al-Sā'irah fī Ma'rafah awṭār al-Dā'irah* which discussed all the known methods of discovering the circumstances of circle.³⁰² Al-Bīrūnī did not confine himself to a simple description of the subject matter with which he was concerned. He compared it with other relevant material and evidence, evaluated and criticised it and offered better solutions. One may surmise that this risālah was written in the same style.

However, the main book which deals with al-Bīrūnī's contribution to trigonometry is *Qānūn al-Mas'ūdī*. Its tenth *maqalah* (treatise) discusses various problems. A detailed study will reveal the importance of this work.

The use of *Jayb* (Sanskrit *Jiva*) was learnt by the Arabs from India. However, the Muslim scientists such as al-Battānī, Abū Naṣr Maṣṣūr, Abū al-Wafā made important additions to this branch of knowledge. But it goes to the credit of al-Bīrūnī that he regarded trigonometry as a separate discipline from astronomy and developed it systematically, though, as a scholar of astronomy he could have been expected to keep the two combined. It reveals the subtle grasp and deep understanding of al-Bīrūnī over his field of study.

The treatise of *Qānūn al-Mas'ūdī* dealing with trigonometry consists of ten chapters. The first chapter describes methods of finding the sides of various figures such as from equilateral triangle and squares to decagons for the given radius of a circle. He provided his own proof of determining the side of a decagon and of a nonagon.³⁰³

In his discussions instead of using abstract numbers he tried to explain his problems in words: "If we wish to find the chord of an octagon, we should multiply the radius by the difference of the radius and the chord of a square, subtract the result from the square

of the radius, and then extract the square root".³⁰⁴

The next chapter discusses the ways of finding the various chords of arcs, i.e., complementary arc, of the double and one-half of the arc etc. He used these theories in determining the sines of multiples and submultiples of angles.³⁰⁵

In the third chapter he discussed the methods of determining the sides of a nonagon from the side of an equilateral triangle. It reduced the problems of "determining the chord of $1/3$ of the given arc, or to find $\Theta/3$ if sine Θ is given".

Al-Bīrūnī was a great geometrician and calculator as well. He did not remain confined to one branch only and whenever the need arose, he had recourse with great facility to other branches of geometry to achieve his results. He used the cubic equation $x^3 = 3x - 1$ or change of the sexagesimal scale to the decimal scale only to extract the root.³⁰⁶

Then he proceeds to discuss the value of chord 1° or sine $1/2^\circ$ in the fifth chapter. On the correct working of these calculations depended the accuracy of the tables. "It is here that he displays his great geometrical curiosity in deriving 12 geometrical relations after assuming that the trisection of an angle is possible".

During these discussions he criticized the value of chord 1° by Ptolemy and Ya'qūb Sihrī with an incisive remarks: "Both the methods give results correct to the second order, but Ptolemy understood what he did, whilst Ya'qūb did not know what he was doing". Al-Bīrūnī himself put forward three methods of finding the value upto the 5th order.³⁰⁷

The fifth chapter of the *maqālāt* deals with the calculation of π . After determining the ratio of the diameters to the perimeters of regular polygons of 180 sides, inscribed and circumscribed in the unit circle, which corresponds to $2/360$ sine 1° and $\frac{360 \tan 1^\circ}{2}$. Al-Bīrūnī realised that the value of π is intermediate between the two values i.e., $3^\circ 8^i 2^{aii} 35^{iii} 24^{iv}$ and $3^\circ 8^i 30^{ii} 17^{iii} 46^{iv} 46^v 30^{vi}$. He then changed it into the vulgar fraction as $\frac{1628681471}{518400000}$ = 3.1417482. Here also he was able to interchange sexagesimal scale into a vulgar fraction and *vice versa*.³⁰⁸

The next two chapters discuss the radius of the circle as unity instead of 60, thus shortening the labours involved in computation.

An idea of his labour in working out his tables may be formed from the following extract:

| <i>Satr ad al</i> | | <i>Al-Jyūb</i> | | | | <i>Al-ta'adil</i> | | | | <i>al-Fuḍūl</i> | | | |
|--------------------|----|----------------|----|----|----|-------------------|----|----|----|-----------------|----|----|--|
| <i>Qūsī (arcs)</i> | | (Sines) | | | | (Equalisations) | | | | Differences | | | |
| 0 | 1 | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | 2 | 3 | 4 | |
| 24 | 0 | 24 | 24 | 15 | 7 | 0 | 57 | 20 | 32 | 14 | 20 | 8 | |
| | 15 | 24 | 38 | 35 | 15 | 0 | 57 | 13 | 16 | 14 | 18 | 20 | |
| | 30 | 24 | 52 | 53 | 44 | 0 | 57 | 7 | 4 | 14 | 16 | 46 | |
| | 45 | 25 | 7 | 10 | 30 | 0 | 57 | 0 | 8 | 14 | 15 | 2 | |
| 25 | 0 | 25 | 21 | 25 | 32 | 0 | 56 | 53 | 16 | 14 | 13 | 19 | |

He knew that sine of an angle can be expended in terms of a polynomial, e.g.,

$$< \frac{10}{4}$$

$$1. \sin(\kappa + X) = u_0 + XT_0 = u_0 + uX^{\Delta_0} \left(X \sqrt[io]{4} \right) \quad T_0 = 4 \Delta$$

$$2. \sin(\kappa + X) = u_0 + 4X^{\Delta} - 1 = (4X)^2 (\Delta - 1 - \Delta_0)$$

On the above basis he put forward two formulae for interpolation.

(\mathbb{X} is an increment on κ and after computation the result comes)

$$\mathbb{X} = \frac{\frac{1}{4} \Delta_0 \Theta(u_0 \pm U_0)}{\Delta_1 \pm 1 \Delta_0 - (U_0 + \mathbb{X} + U_0) (\Delta_1 - \Delta_0)}$$

Before the 17th century it was the first example of calculus in classical mathematics.³⁰⁹

While discussing the measurements of *Umbra Versa* (*d̥hil ma'kūs*) and *Umbra recta* (*d̥hil mustawī*) al-Bīrūnī with characteristic frankness brought to light the fact that the length of the measuring rod (*miqyās*) for the shadow was generally taken as twelve parts (fingers) for *Umbra recta*. This was what Indian astronomers always used to do. Thus it is clear that al-Bīrūnī was indebted in this respect to Indians.³¹⁰

He made a thorough discussion of tangent, cotangent, secant, cosecant, sine, cosine, versine and coversine in terms of tangent tables and *vice versa*. In discussing the method for finding more proximately from any table whatsoever he gave a general theorem formulated in the language of the theory of function. None of his predecessors or his contemporaries was able to achieve it. He was able to surpass all the mathematicians since Ptolemy in providing the proof of sine formula of plane triangles, i.e.,

$$\frac{\text{Sine } A}{a} = \frac{\text{Sine } B}{b} = \frac{\text{Sine } C}{c}$$

In the last two chapters he provides study of relations between sine and tangents of great circular arcs in the figures formed by pairs of intersecting quadrants and proves that:

$$(i) \quad \frac{\sin RT}{\sin DT} = \frac{\sin RB}{\sin BC} \quad (ii) \quad \frac{\sin RD}{\sin RC} = \frac{\tan DT}{\tan BC}$$

These properties were put to use in chapters XII, XIV, XVII and XVIII of the 4th *maqālah* for determining eastern and western amplitudes of heavenly bodies, equation of day and latitude thereof, ascensions of signs of the ecliptic etc.³¹¹

In this way al-Bīrūnī's discussions covered a wide field of spherical trigonometry, criticising and evaluating ancient and contemporary knowledge and where possible, providing better solutions. He was the first to provide the proof of sine formulae of plane triangles. He dexterously used formulae and interpolation, and gave the first examples of calculus and general theorem in the language of functional theory.

INDIAN ARITHMETIC

Besides spherical trigonometry al-Bīrūnī was an adept in Indian arithmetic. He wrote a number of books relating to it. Some of these are:

1. *Rāshikāt-al-Hind* (also *Rāshikhāt al-Hind*), i.e., Zodiacs in India; also known as *Tri-Rājik fī Rāshikhāt al-Hind*.
2. The different methods of arithmetic given in *Brahma Siddhant*. It appears to be the translation of the 13th chapter of *Brahma*

3. The Indian methods (*Rasūm al-Hind*) in teaching arithmetic.
4. Computations of sums through *Sind Hind*.
5. *Ki'āh and other methods of computations*.
6. *Risālah* showing that in grading of numbers the Arabs were better than the Indians.
7. *Fi Sakklah al-a'dād*, whose half comprised 30 sheets.
8. *Manṣūbāt al-Darab*, giving different methods of multiplications.

Out of these books *Rāshikhāt al-Hind* discussed the different methods of finding the fourth number from the three given numbers. In this process the first and second have the same relationship as between the third and the fourth. The first and the fourth are called *tarfayn* and second and third as *wastayn*. The whole process has been given the name of *Arab 'ah mutanāsibah*. The Indians were the first to solve these problems. The relationship between similar quantities is a figure of the supplementary figures which are obtained by quiddity; so one of them is not known or may be known. There is no quantity but it has relationship with the quantities of the same genus to the extent it stops or it does not reach it in figure as diameter and circle because of being straight and circular or because of a stopper contradiction which is found in diameter and arm of an angle because of contradiction. So relationship is always obtained between two similar quantities to be obtained freely. It is not limited in itself unless limited or known except when it is combined with another and stops there on two relationships or less than that if the proposition is in three quantities.

"The Hindus call the *tri rāshik* (three dimensional); *rash* means zodiac and *rāshik* is the position of figure as their astrologers call twelve zodiacal signs as *rāshik* and they drew sketches of these three because the information obtained from them are three..."

Further, he says:

"They use numbers and depend in its verification and examination and induction of illustration without indulging in providing with geometrical arguments and they draw two lines

intersecting each other (and) obtain four possible solutions of this illustration and they say: If five are multiplied by fifteen, what will be the quiddity of these three? Then they remove fifteen to a lacunic place and multiply it by three and the product is forty-five. They divide it by five and the quotient is nine and it is to be placed in the lacunic place unless three become nine.

If they divide fifteen by five, the quotient is three and this is equal if the dividend nine is divided by three and the quotient will be three. If they multiply it into thrice the required nine will be obtained and similar examples in division are obtained in the arms of a triangle.³¹³

Fig. 1 $\frac{15}{3}$

Fig. 2 $\frac{15}{9} \frac{5}{3}$

On the same basis the Indians computed the quantities of five relationships (*Panch rāshik*) for finding the sixth quantity and nine relationships (*tarāi rāshik*), for finding the tenth quantity and eleven relationships. Al-Bīrūnī did not find the Hindus going beyond the teaching of *rāshik* although according to him to pass on was possible, nay, obligatory.

The foregoing extract clearly demonstrates al-Bīrūnī's mastery over Indian arithmetic. He justly criticized them for keeping the application of the above mentioned process to *rāshik* and the figure of twelve only.

As stated in the beginning of this chapter, al-Bīrūnī was not interested in music. However, he seemed to have delved into physics (optics, weights and measures) but never regarded himself as a physicist and often left questions relating to physics for others.³¹⁴

Medieval Muslim physics mainly remained confined to the lines laid down by Aristotle. There are different schools who either criticised the Greek philosopher or followed him. Its topics were form, matter, potentiality, actuality, the four causes, and teleology. As the philosophers remained strictly bound by their Greek ideas they were unable to put forward any new ideas. The theologians (*fuqahā*) with their metaphysical ideas, and the gnostics and alchemists by their direct observation of nature provided new open-

ings. This controversy between the theologians and the philosophers was still alive during eleventh century A.D. and was the subject of learned discussions among the great scholars of that age. Besides them there was yet another group, that of the scholars and the scientists who believed in observation, experimentation and analysis. It was not ready to accept anything without verification. It included al-Haytham, al-Bīrūnī and al-Khāzinī. They were Archimedean in their outlook and nearer to modern practice, in that they were the promoters of the inductive approach. They neither attacked Aristotle for the sake of disagreeing with him nor supported him blindfolded. Moreover, to al-Bīrūnī and other Muslim scholars optics and other allied studies were secondary in nature.

Al-Bīrūnī discusses the problems of physics with his characteristic lucidity. His scientific probings touched most of the aspects of physics, viz., motion, gravity, hydraulics, mechanics, weights, heat and light. He seems to have made special study of rays and gravity. He wrote a number of treatises on *'Ilm al-Ash'iyāh wa 'ilm al-Manāzīr* discussing rays and their passage:

1. *Tajrīd al-Shu'āt wa al-Anwār 'an al-Fadā'ih al-Mudawwanah fi al-Asfār* to correct the erroneous concepts about light and rays found in books.
2. *Tahṣīl al-Shu'āt ba ba'd al-Tarq 'an al-Sā'āt*. To find the condition of rays.
3. *Maqūlah fi Matrah alshu'a Thābita 'ala Taghaiyyur al-Baqā*.
4. *Tamhīd al-Mastaqar al-Ma'nī al-Mamar* dealing with the condition of *Mamar*.³¹⁵

LIGHT AND SOUND

Al-Bīrūnī correctly believed that the speed of light was far greater than that of sound. He thought that the rays carry heat from the sun and they can penetrate air and water. He rejected the Aristotelian concept that vision was made possible by emission of rays from the eyes and rightly asserted the opposite view that rays emanated from objects and not from eyes. Independent of al-Haytham he found out that twilight begins or ceases when the sun is 18° below the horizon.³¹⁶ Al-Bīrūnī's measurement corresponds

to modern findings and is, therefore, better than al-Haytham's, 19^o. A better appreciation of his contribution in optics should have been possible, if his *al-Lam'at* were extant today.

GRAVITY

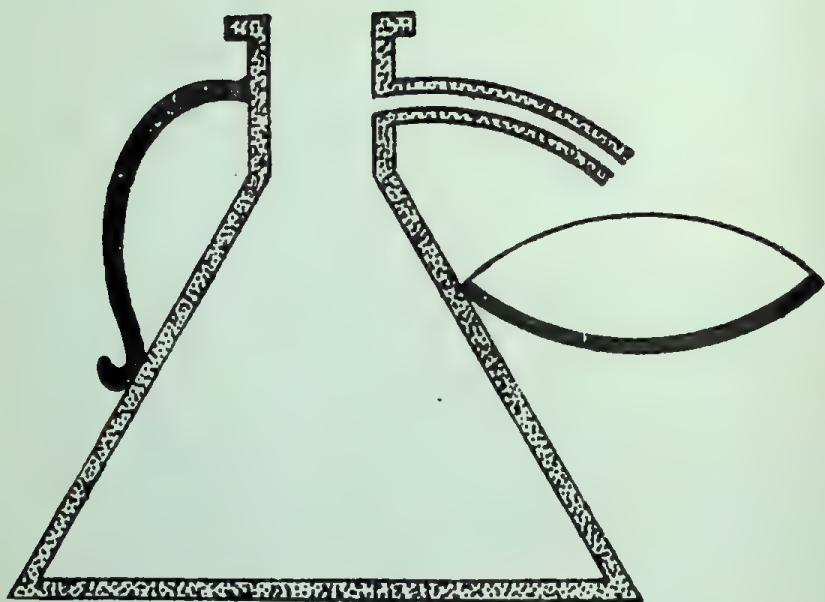
In the field of gravity he made notable contributions. He rejected Aristotle's contention that heavens did not possess gravity. As gravity makes objects move towards the centre, the heavens because they were interconnected were prevented from falling, otherwise in their movement towards the centre they could have fallen. Similarly, he rejected the idea that the natural place of water was above the earth, for there is no 'natural place' for any body. If water was allowed a free flow, it would reach the centre.

DENSITY

He was able to measure correctly the density of substances. Al-Khazini described an instrument which al-Biruni used in measuring densities. It was a conical instrument which served as dosimeter or hydrostatic balance.³¹⁷ The weighed substance was put in the vessel which was full of water. The displaced water was weighed and the result was the specific weight of that substance. The instrument appears to be based on the famous experiment of Archimedes. Al-Biruni referred to another instrument called *al-dahj* and the lamp (*Siraj al-Khadim naqshah*) in which the level of the water and the oil remained constant since the excessive quantity drained out of the holes made for that purpose.³¹⁸ Al-Biruni was able to measure the displaced water with such exactitude that his findings nearly correspond with the modern values. An idea may be formed from the extract³¹⁹ on the following page.

Al-Biruni used gold, mercury, emerald and quartz and determined their value (given in paranthesis) while the other substances were measured on these fixed values.

Another field where al-Biruni made original contributions was that of hydrostatics. He explained the phenomenon of floods, bubbling springs and the principle involved in their working. He



The conical-shaped instrument invented by al-Bīrūnī to measure density

| Substance | Al-Bīrūnī | | Khāzini | Modern |
|-----------|------------------------|------------------------|---------|--------|
| | Measured by gold | Measured by mercury | | |
| Gold | 19.26 | 19.05 | 19.05 | 19.26 |
| Mercury | 13.74 | 13.59 | 13.56 | 13.59 |
| Copper | 8.92 | 8.83 | 8.66 | 8.85 |
| Brass | 8.67 | 8.58 | 8.57 | 8.4 |
| Iron | 7.82 | 7.74 | 7.74 | 7.79 |
| Tin | 7.22 | 7.15 | 7.32 | 7.29 |
| Lead | 11.40 | 11.29 | 11.32 | 11.35 |
| | Measured by emerald | Measured by quartz | | |
| Sapphire | 3.91 | 3.76 | 3.96 | 3.90 |
| Ruby | 3.75 | 3.60 | 3.58 | 3.52 |
| Emerald | 2.73 | 2.62 | 2.60 | 2.73 |
| Pearl | 2.73 | 2.62 | 2.60 | 2.75 |
| Quartz | 2.53 | 2.58 | — | 2.58 |

pointed out the fact that level and flow of water depended upon the level of the source of water. He contended that such behaviour of water depended upon other factors such as the influence and pressure exerted by air; otherwise, water on its own would flow towards the centre of earth. He explained it with the help of an instrument called *sarqalah al-mā'* (probably a syphon) in which the level of water remained constant in both the wings till the ends were placed in vessels filled with water and placed at equal heights. As soon as one end was lowered the water would flow out of it due to earth's gravity. On the same principle he explained the phenomenon of springs or wells having constant level.^{3 20}

He also discussed the divisibility of water and space, the real form of fire, motion etc.

MECHANICS

In the field of mechanics as well, al-Bīrūnī's contributions were remarkable. He was well-versed in *'ilm al-ālāh* (knowledge of instruments). Besides using instruments to illustrate the various explanations advanced by him and the theories he had put forward

he invented two very remarkable instruments. One such instrument was the hydrostatic balance which helped him in finding the correct densities of eighteen substances. The other was a new type of astrolabe called *al-Ustawānī* which helped him to measure the height of heavenly bodies, their apogees, time, depth of wells or rivers and heights of walls, towers and hills which were inaccessible otherwise. This instrument was completed by the time the *Kitāb al-Tafhīm* was written in 1029 A.D.³²¹ Al-Bīrūnī had written a treatise on the measurement of the inaccessible distances entitled *al-Irshād ala ma Yadrak wa lā Yanāl min al-'abād* but its manuscript was incomplete till 1035 A.D.³²² Al-Bīrūnī always indited his findings after he had completely satisfied himself by experiments and the above example amply proves this view. He was fair enough to appreciate the astrolabe *Zuraqi* of Abū Sa'īd Sijzi which was based on the concept of the earth's motion around the sun.³²³ Besides the *Kitāb al-Irshād* he composed a number of other treatises on this subject. Some of these worth mentioning are:³²⁴

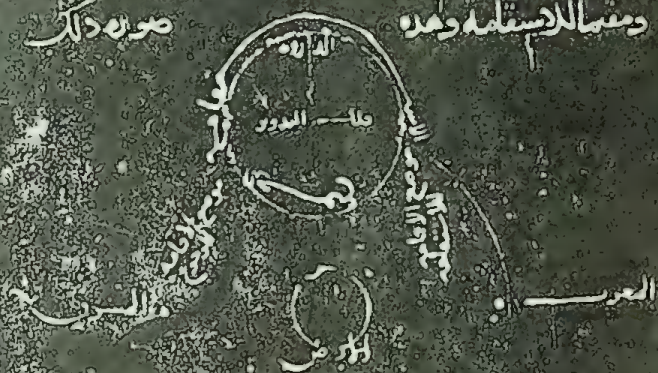
1. A treatise dealing with the different possible ways of manufacturing astrolabes.
2. Methods for rectifying the astrolabes and easy methods for using the north and south sections of this equipment.
3. *Fī mā akhrāj mā fī quwah uṣṭarlāb ila al f'al* discussing the different uses of astrolabes.
4. The use of *Uṣṭarlāb al-Kūrī* (the circular astrolabe).

WEIGHTS AND MEASURES

Interest in mathematics led al-Bīrūnī to study weights and measures for they were allied to the study of astronomy and physics. The wonderfully correct densities of the eighteen substances as measured by al-Bīrūnī show his skill in preparing most correct weights and measures. In 1035, he had an incomplete manuscript of *al-Kitāb fī al-Makāyīl wa al-Mawāzin wa Sharā'it al Tayār wa al-Shawāhīn* with measures and weights and about the conditions governing both the wings of balance.³²⁵ He had exhaustively dealt with the Hindu measurements, in *al-Hind*. The general remarks in *al-Hind*'s description show al-Bīrūnī's insight:

كانت فصلا منهن اذ يبطا الكوكب لذلك فان كان الكوكب في فصل ما منه ما رجوعا
 كان احدى الساطعين السيارين يكون قد مر ما والاخرى ما اخر اذ اذ ما اوصافه
 كانت الفصل التي لنا اخر وكات رجوعا او يسار فكان الكوكب في صف في موضعه
 ساري له حركه هذا الكون في اول الرجوع واخره ويسمى الكوكب حينئذ ما بالرجوع
 ومنها الاستقامة وهذه

صوره ذلك



ما بالعلم به ان كان الكوكب في الساتر ما بالعلوه وحل في الساتر في الساتر
 والسفله في الزمره وعطارد والعمرق في الساتر من حمله المعبره وهذا
 السفل والعلو مفصل الى الساتر ومن الساتر ما بالعلم به ان كان الكوكب في الساتر
 العلوه ومنه احوالها جميعا الهماء خاصه دور القمر ورجوع المعبره والقمر

صورة فؤوغرافية من مخطوط

تحقيق ما للهند

"Counting is innate to man. The measure of a thing becomes known by its being compared with another thing which belongs to the same species and is assumed as a unit by general consent. Thereby the difference between the object and this standard becomes known. By weighing, people determine the amount of gravity of heavy bodies, when the tongue of scales stands at right angles on horizontal plane..."

And again:

"Since the unit of measure is not a natural unit, but a conventional one assumed by general consent, it admits both practical and imaginary division. Its subdivisions or fractions are different in different periods in one and the same country. Their names, too, are different according to places and times; changes which are reproduced, either by the organic development of languages or by accident."

Further, he says:

"By measuring (with dry measures) people determine the body and the bulk of a thing, if it fills up a certain measure which has been gauged as containing a certain quality of it, it being understood that the way in which their surface is determined, and the way in which, on the whole, they are arranged within the measure, are in every case identical. If two objects which are to be weighed belong to the same species, they then prove to be equal, not only in bulk, but also in weight; but if they do not belong to the same species, their bodily extent is equal, but not their weight."

And lastly:

"Mensuration is the determination of distances by lines and of superficies by planes. A plane ought to be measured by part of a plane, but the mensuration by means of lines effects the same purpose, as lines determine the limits of planes".^{3 2 6}

The foregoing discussion demonstrates al-Bīrūnī's achievements

in all the branches of mathematics and allied studies, except music which he seems to ignore altogether. It does not mean that he was ignorant of it. As he was not fond of music he could have acquired only a working knowledge of it.

Chemistry and alchemy also came under al-Bīrūnī's purview. His *al-tanbīh alī Ṣana'ah al-Tamwīh* deals with gilding while *al-Burhān al-munīr fī a'māl al-tisīr* discusses chemical actions.³²⁷ However, he was highly intolerant of alchemy and regarded it as one of the species of witchcraft, which makes "some kind of delusion; a thing appearing to the senses as something different from what it is in reality". He asserted that to produce some impossible thing did not lie within the limits of reality. However, as a true scientist and seeker of knowledge he appears to be acquainted with alchemy's methodology, i.e., mineral, animal and vegetable one. He discussed the science of *Rasayana* (alchemy) of the Hindus and appalled by its debasing influence fervently wished that it should be banished to the utmost limits of the world.³²⁸

It may be safely presumed that al-Bīrūnī like other educated persons of his days had studied medicine also. Had it not been for *Kitāb al-Ṣaydanah*, he could have been described to have willingly ignored this science. Most of the Greek medical knowledge had been translated into Arabic by this time. Great clinical scientists such as al-Rāzī and Ibn Sīnā were the products of this age. *Kitāb al-Ṣaydanah* discusses occurrence, medicinal uses, identification, and ecology of natural drugs. He was so keen to know their exact names in Greek that he did his best to learn the correct pronunciation and generally his transcriptions of Greek names are correct. Al-Bīrūnī's approach towards natural drugs is partly etymological, partly encyclopaedic (polymath), and in part a revised version of the opinions of the Greek masters. He, however, displays, here also, a very original mind.

Medicine, after all, belonged to the same class of sciences as astronomy.³²⁹ He was familiar with the Greek and Indian medicine and was at home with the works of Galen, Hippocrates, and Chāraka who was regarded by the Hindus as the best of their medical men.³³⁰ He translated *Kalpa Yārah* which discussed diseases born of putrefaction.³³¹ However, his main contribution was not in the

practice of medicine but in the pharmacopoeic studies. He tried to remove the problems of the work of Shaykh Abū Hamid bin Muhammad b. Ahmad al-Sahtashqī. The arrangement follows *hurūf-i-mu'jam* giving name of a single remedy, its Arabic, Greek, Syriac, Jurjāniyan, Khwārizmi, Persian, Iraqi, Hindi or Sindhi equivalents, followed by its characteristics. He had seen *Dah-nāmah* which purported to give names of terms and words in ten languages, a claim which he found to be incorrect. The Christians had the *Yashāq Shamāhi* (i.e. Commentary of Names of Syriac) also known as *Chahār Nām* which gave equivalents in Greek, Syriac, Arabic and Persian. Al-Bīrūnī possessed one of its copy in Syriac script. He also acquired the book of Herbs, very useful with pictures and the *Kinnash* of Oribasius in which the Greek equivalents were given against all medicaments and he copied them because he had confidence in them.³³² He checked these names further and consulted a Greek merchant with samples of seeds etc. In this way al-Bīrūnī possessed a sufficient knowledge of Hellenic and Arabic medicine. He combined it with his knowledge of Sanskrit and where possible added new information or corrected old misconceptions by diligent inquiries. He asked the ambassadors from Qitay Khān about the value they attached to *khatū*. All these efforts made the *Kitāb al-Saydanah* a very comprehensive book on pharmacy.

GEOGRAPHY, GEODESY, STRATOGRAPHY ETC.

Geography was one of the sciences in which the Arabs as desert dwellers were interested from the very beginning. Islam with its practical approach in solving human problems encouraged travelling in the form of Haj so as to break parochial thinking and at the same time provided concessions in religious duties such as exemption from fasting and decreasing the number of *rak'ahs* in prayer to facilitate travelling. The importance of travelling as a medium of educating and broadening one's mind was also appreciated and as the dissemination of learning was difficult Islam exhorted its followers to travel and acquire knowledge from wherever possible. At the same time expansion of the Caliphate conferred political unity, a common *lingua franca*, and a common bond of religion with

safety and security of travel and for the first time in history made journey across the greater length of the populated world (*Ruba'-i-maskūn*) possible.³³³ Trade and commerce flourished and thus presented increased opportunities for travelling. Invention and the use of travelling aids such as astrolabe and compass were added incentives. As knowledge of countries and ways increased, travelling became easier and commoner. It appears that a spirit of inquiry and a desire to know combined with the spirit of adventure possessed the Muslims, a phenomenon that history has witnessed again with the awakening of Europe. Translations of old books of geography, travel accounts of the Muslim travellers, better knowledge of distances acquired with the help of astronomy and mathematics provided better knowledge of geography. The requirement of the state also encouraged studies in exact measurement of distances and areas and other relevant data. The spirit of learning also actuated rulers such as Ma'mūn to encourage these studies, and the expeditions organised under his rule to measure the circumference of the earth is a point in this respect. Thus the Arabs, by their efforts, forged links between the past and the present and provided one of the bases of the Renaissance of learning and humanism in Europe.

Al-Khwarizmi's book, *Shape of the Earth*, made the science of geography a methodical study. The tenth century was a glorious period in the development of geographical knowledge. A number of travellers visited different countries and preserved their experiences and knowledge in writing. The merchant Sulaymān, al-Istakhrī, Ibn Hawqal, and al-Mas'ūdī rank as among the great pioneers in this regard. As geography was a branch of astronomy which in itself was an offshoot of mathematics, it was natural for al-Bīrūnī to be interested in geography — and particularly in astronomical geography. Though he was not a globe trotter on the scale of his illustrious predecessors his contribution to geography is of the highest order. He contributed mainly in the astronomical side of his studies. He also travelled. But he was a traveller with a difference. He was not motivated by any spirit of adventure or sight-seeing. Nor did he want to record his findings so that his name should become embossed upon human memory.³³⁴ His sole aim in visiting India

was to learn Indian sciences. His visits remained confined to the Punjab only, nevertheless he left such a record of the conditions of India, its beliefs and sciences that his book *India* ranks with the accounts of Hiuen Tsang and Babar and in some respect excels them.³³⁵ He wrote that book so that any one who wanted to have a religious or philosophical discussion with the Hindus of India might be able to know something about them.³³⁶ Al-Bīrūnī himself was not a religious missionary; still he knew that contacts with India would lead to such confrontations and discussions, and such discussions could have been going on, for Muslim missionaries such as 'Alī Hajwayrī had settled down at Lahore. It would be an interesting study how far al-Bīrūnī's masterpiece strengthened the hands of Muslim missionaries.

Al-Bīrūnī was fully alive to the study of geography and astronomy. An attack by a lexicographer on the utility of *Kitāb al-Masālik wa al-Mamālik* infuriated him and in order to do justice to this branch of knowledge he wrote *Kitāb fī Tahdīd Nihāyat al-Masākin*.³³⁷ He had studied the subject extensively and was intending to collect the information from Ptolemy and al-Jayhānī and others into one composite whole.³³⁸ Besides *al-Tahdīd* he wrote books on longitudes and latitudes and finding the correct direction of *qiblah*. There are scattered references in his other books such as the *Chronology* and *Qānūn al-Mas'ūdī*. Important geographical discussions also occur in *India* as well.

Al-Bīrūnī was cognizant of the fact that some people were accustomed to little geographical knowledge. But as he argued in his introduction of *al-Tahdīd*, the knowledge of countries and of routes was not against the *Qur'ān*. On the other hand, references to the travels of saints, of Dhu' al-Qarnayn reaching the place of the rising and setting of the sun, Moses coming to the meeting of the Seas, *Mi'raj* of the Prophet (peace be on him) and his migration to Medina and later his expeditions, justify this knowledge. He also knew that earlier hostile regions forbade travelling but the spread of Islam had destroyed this animosity. "Thus different people are brought in mutual understanding".³³⁹

Al-Bīrūnī found the universe not eternal but everchanging and argued that it was impossible to fix its age.³⁴⁰ In the same way he

had refused to believe the stories and myths of origin of man and universe, of different religions, i.e., Christianity, Judaism and Hinduism.³⁴¹ He found it futile to estimate the dates for such remote events. Similarly he refused to accept notions of earth's origin. According to him its age could be of millions of years.³⁴² He agreed with Aristotle that originally the earth was probably in a liquid state.³⁴³ He regarded it as a globe. He believed in the geo-centric theory but was aware of the helio-centric point of view as well.

His theories about the earth's distant origin stem from his observations of geological transformation pointing to long periods of changes; hence earth's antiquity. He compared the petrified and stratified remains discovered in the plains of Arabia, in Jurjān and Khwārizm along the Caspian Sea which proved existence of sea at these places in some bygone age while history possessed no such record.³⁴⁴ The Indo-Gangetic plain was also formed by the silt brought by the rivers. He argued that as geological changes due to the action of water and air took a long time to complete, in his own days it was but logical to deduce that the geological changes as evidenced by the petrified remains must have taken a longer period to occur.

He had also discussed floods, formation of fountains etc. His study of the changes of rivers of Jurjāniyah and the rivers of Balkh and Oxus shows his deep insight. He found that the course of the Oxus had undergone a change since the days of Ptolemy – a period of eight hundred years and he also explained how the life of the regions and people was affected by these changes.

In the age of al-Bīrūnī the earth was divided into the populated and the unpopulated world. It was generally believed that beyond the populated world there was nothing except water. Al-Bīrūnī's practical mind refused to accept mere surmises. Let us quote his words: "There is nothing to prohibit the existence of inhabitable lands in the Eastern and Western parts. Neither extreme heat nor cold stands in the way and therefore it is necessary that some supposed regions do exist beyond (the known) remaining regions of the world surrounded by water on all sides."³⁴⁵ In this way he was not ready to accept the limited current view of *Ruba'-i-maskūn*.

He correctly estimated the known habitable world as greater in length, i.e., from China in the east to Morocco and Spain in the west. Extreme cold checked the spread of population in the north and in the south.³⁴⁶ The seas limited inhabitable land. The known world was divided into the age-old sevenfold divisions of seven *aqālīm*.

The known world was surrounded by a "comprehending sea" which separates it from whatever continent or inhabitable islands there may be beyond it, both towards west and east; for it is not navigable, on account of darkness of the air and the thickness of the water, because there is no route traceable and because the risk is enormous, whilst the profit is nothing".³⁴⁷

The above-mentioned passage is a strange mixture of fact and fiction. Al-Bīrūnī's forceful argument about the possibility of inhabited regions on the other side of the earth stops at this only. His next argument explaining the lack of information due to the non-navigability of the ocean due to darkness of the air and thickness of water might be an echo of the misconceptions rampant in the medieval world. This lapse on his part to apply his earlier logic to such misconceptions shows the force of old myths and fables. His following argument is again very logical and shows his practical approach. Lack of information about the route and the enormous and unknown risks involved without the stimulation provided by possible gain checked any move in this direction. When works of the Portuguese navigators provided better knowledge of the Atlantic and mercantile and religious urge to discover a new route to the Indies developed, only then was it possible for the sailors to go out into the unknown sea and discover new lands. However, had these conditions been present in the Muslim period, their sailors would have been able to undertake their journey with a better appreciation of the distances involved.³⁴⁸

Al-Bīrūnī also had a correct idea of the different bays and gulfs and smaller seas protruding from the great ocean or others which were linked with it. He referred to the Ice Sea in the north-east of Europe and West of Tangier and Spain. He also mentioned the sea of Warang (Norsemen), i.e., probably the Baltic. In the south of Europe he was aware of the presence of the ocean in the form of

gulfs upto Sicily and Bulgaria.

The Indian Ocean, he mentioned, as being pricked by islands and understands that it met the big comprehending sea, in the east and possibly below Africa in the west. The latter inference was drawn by the reports of shipwrecks of Indian type of ships found at Gibraltar, though an actual observation of such a likelihood (Union of Seas) was not possible. The Indian Ocean also had its links with the Klymsa sea (Red Sea) and with the sea of Persia. He referred to the seas of China and mentioned the fact that in the east the seas were named after the islands or the countries.³⁴⁹

He also differentiated between estuaries and bays. The former were described mouths of rivers and the latter as the jutting of the sea into land. He regarded the whole mass of Eurasia and Africa as one continent which he found embracing equally the West and the East. The former due to their standing fresh water could not sustain heavy loads of ships while the latter were risky due to their ebb and tide.³⁵⁰

The great geographer knew about the huge mountain range known in India as Himavant (the Himalayas) which spread across the length of the known world like the spinal bone. From China in the east it extended into Tibet, Turkistan, Kabul, Badakhshan, Tukhāristān, Bāmiyān, Elghier, Khurasan, Media, Adharbijan, Armenia, the Roman Empire (the Byzantium and Italy), the country of the Franks and Jalāliqa (Galicia). In *India* he discussed the role of these mountains in providing heavy rain to the regions to the south while keeping a part of Kashmir without regular rains.³⁵¹

As stated earlier, he had some idea about the coastal outline of Europe and knew the names of bays and seas surrounding it. He also mentioned the Warangs and their predatory habits.³⁵² There was mineral industry in North Europe. He referred to the Sawars, Bulgars, Russians, Slavs and Azovs in the West and the country of the Franks and Galicia, situated beyond the Roman Empire at the western arm of Europe.

In this region the African continent extended far into the south. He thought that probably the Indian Ocean met with the great ocean (the Atlantic) below it, though in his days it was not possible to verify it. He referred to the mountain of Moon situated near the

equator and which was the source of the Nile.³⁵³ He described the reason of floods in the Nile and attributed them to the heavy rains, in its catchment area.³⁵⁴ In the west of that mass of land were the Negro slaves (Nigeria and Guinea Coast areas). There were the tribes of Zanj and the regions of Berbers.³⁵⁵ In fact, the Muslims knew little of Africa beyond the equator.

Al-Bīrūnī's knowledge about Asia was also extensive. The great mass of mountain ranges he held to be the source of most of the rivers. He provided some detailed information about the land of the Turks, identified in the Augarer river and the region of the Baikal lake in eastern Siberia.³⁵⁶

However, his main contribution was the description of India. His estimate of India's extent from the forts of lower Kashmir to the Deccan peninsula is "amazingly close to the real dimensions of the sub-continent".³⁵⁷ He had an idea of its peninsular form. The mountains of Himavant and Meru (Pamirs?) surrounded it in the north. His information about southern India appears to be confused. He regards the Eastern and Western Ghats as extension of the great northern range.³⁵⁸ They controlled its rain and most of the rivers flowed from them.³⁵⁹ He provided a detailed study of their sources and passage. However, except the Indus, his information about the other rivers is limited to the location of their mouths based on hearsay and knowledge from ancient books, e.g., *Matsya Purana*. He gave the first correct information about the Indus – its origin, passage and floods. Much of this information was derived from reliable witnesses or books. However, information about Afghanistan and the Punjab was based on his personal observations as well. It may be pointed out that in his description of the rivers of India and its coastline he provided better information than Babar. But it must be conceded that Babar was writing a royal memoir while al-Bīrūnī was writing a book on India itself, and, therefore, he used all means at his disposal to acquire that knowledge. As he possessed a flair for geography he looked for that information in India while Babar, busy with his regal and administrative pre-occupations, had neither leisure nor desire for such a study. It goes to the latter's credit that notwithstanding the limitations imposed by his eminent position and interests he was able to provide the posterity

with a vast amount of diversified information. An idea may be formed of the description of the Indus given by al-Bīrūnī by a study of the relevant passages:

The river Sindh rises in the mountains of Unang in the territory of the Turks.... Marching on the left side of the river, you always pass through cultivated ground.³⁶⁰ The Jailam (one of the tributaries of the Indus) rises in the mountains of Haramkāt where also the Ganges rises, cold, impenetrable regions where the snow never melts nor disappears. Behind them there is Mahācīn, i.e., Great China. When the Jailam has left the mountains, and has flowed two days' journey, it passes through Addishtan. Four *farsakh* farther on, it enters a swamp of one square *farsakh*. The people have their plantations on the borders of this swamp, and on such parts of it as they manage to reclaim; leaving this swamp, the Jailam passes the town Ushkira, and then enters the ravine (above Addishtan).... The Kusnārī and Mahwī rising in the mountains of Shamīlān fall into the Jailam.

In the mountains bordering on the Kingdom of K. yabish, i.e., Kabul, rises a river which is called Gherwand, on account of its many branches. It is joined by several affluents:

1. The river of the pass of Ghuzak.
2. The river of the gorge of Panchir, below the town of Parwan.
- 3 and 4. The river Sharvat and the river Sawa, which later flows through the town of Larbagā, i.e., Lamghān, join Gherwand at the fortress of Drūta.
- 5 and 6. The rivers Nūr and Kīrā.

Swelled by these affluents, the Gherwand is a great river opposite the town of Purshāwar, being there called the ford from a ford near the village of Mahanāra, on the eastern banks of the river, and it falls into the river Sindh near the castle of Bītūr, below the capital of al-Kandahar (Gandhara), i.e., Vaihind.

The river Biyatta, known as Jailam, from the city of this name on its western bank, and the river Candaraha (Chandraha)

join each other nearly fifty miles above Jaharāvar, and pass along west of Multan.³⁶¹

Further, he goes on:

The river Biyah flows east of Multan, and joins afterwards the Biyatta and Candaraha. The river Irwa is joined by the river Kaj, which rises in Nagarkot in the mountains of Bhātul. Thereupon follows as the fifth the river Shaltladar (Sutlej).

After these five rivers have united below Multan at place called *Pancanade* (Panchnada), i.e., the meeting place of the five rivers, they form an enormous water-course. In flood times it sometimes swells to such a degree as to cover nearly a space of ten *farsakh*, and to rise above the tree of the plains, so that afterwards the rubbish carried by the floods is found in their higher branches like birds-nests.³⁶²

The Muslims call the river, after it has passed the Sindhi city Aror, as a united stream, the river of Mihran. Thus it extends, flowing straight on, becoming broader and broader, and gaining in purity of water, enclosing in its course places like islands, until it reaches Almansura, situated between several of its arms, and flows into the ocean at two places, near the city Loharānī, and more eastward in the province of Kachch at a place called Sindhū-Sāgara, i.e., the Sindh Sea. The two mouths were known as the small *Munha* (mouth) and the great *Munha*.³⁶³

Al-Bīrūnī provided valuable information about north-western India, particularly the hilly terrain of Kashmir etc. But he gave interesting glimpses of other territories as well.

About Gilgit, for example, he says that it is two days' march from the plateau of Kashmir. On the left are the mountains of Bolar and Shamīlān where the Turkish tribes of Bhatta Varyan lived. Their king was styled Bhatta-Shāh and their towns were Gilgit, Aswira and Shiltās. The people spoke Turkish. Their predatory habits caused great trouble to the people of Kashmir.³⁶⁴

He says about Kashmir as follows:

Kashmir lies on a plateau surrounded by inaccessible mountains. The south and east of the country belong to the Hindus, the west to various kings, the Bolar-Shāh and the Shugnan-Shāh, and the more remote parts upto the frontiers of Badakhshan, to the Wakhān-Shāh. The north and part of the east of the country belong to the Turks of Khoten and Tibet. The distance from the peak of Bhotesar to Kashmir through Tibet amounts to nearly 300 *farsakh*.

The inhabitants of Kashmir are pedestrians, they have no riding animals or elephants. The nobles among them ride in planquins called *katt*, carried on the shoulders of men. They are particularly anxious about the natural strength of their country, and therefore take always much care to keep a stronghold upon the entrances and roads leading into it. In consequence it is very difficult to have any commerce with them. In former times they used to allow one or two foreigners to enter their country, particularly Jews, but at present they do not allow any Hindu whom they do not know personally to enter, much less other people.

The best known entrance to Kashmir is from the town Babrahān, half way between the rivers Sindh and Jailam. Thence to the bridge over the river, where the water of the Kusnari is joined by two tributaries the distance is 8 *farsakh*. Thence you reach in five days the beginning of the ravine whence the river Jailam comes; at the other end of this ravine is the watch-station Dvar, on both sides of the river Jailam. Thence, leaving the ravine, you enter the plain, and reach in two more days Addishtan, the capital of Kashmir, passing on the road the village Ūshkāṛā, which lies on both sides of the valley, in the same manner as Baramula.³⁶⁵ The city of Kashmir covers a space of four *farsakh*, being built along both banks of the river Jailam, which are connected with each other by bridges and ferry boats.

He goes on to write:

In provinces still farther northward, round the mountains of Kashmir upto the peak of Jūdārī between Dunpūr and

Barshawār, copious rain falls during two and a half months, beginning with the month *Srāvna*. However, on the other side of this peak, there is no rainfall; for the clouds in the north are very heavy, and do not rise much above the surface. When, they reach the mountains, the mountain-sides strike against them, and the clouds are pressed like olives or grapes, in consequence of which the rain pours down, and the clouds never pass beyond the mountains. Therefore Kashmir has no *varshakāla*, but continual snowfall during two and a half months, beginning with *Māgha*, and shortly after the middle *caitra*, continual rain sets in for a few days, melting the snow and cleansing the earth.³⁶⁶

People told al-Bīrūnī about Nepal and Tibet. From Nepal to Bhoteshar, the first frontier town of Tibet was a very difficult terrain criss-crossed with rope bridges along which goods were transported by labourers and by goats. The people of Bhoteshar were different in language, costumes and descent. From the highest peak which was 20 *farsakh* high the Indian plains appeared black and Tibet and China as red.³⁶⁷

Al-Biruni dilates upon the geographical and political importance of *Madhyadesha*, the country around Qannauj, the city traditionally associated with the Pandavas. The ruins of ancient Qannauj lie west of the Ganges while a new town Bari was on the east of the river. Sind was west of Qannauj and it could be entered from the side of Nimroz or Sijistān. While discussing distances he provided information about the capitals of different kingdoms such as Mandahukar the capital of Lauhāwar, Kajūrāha the capital of Jajāhūti, Bazna the capital of Guzarat, Jattaraur (Chittor) capital of Maiwar, Dher the capital of Malwa and Tana capital of Kunkan.³⁶⁸

It is rather interesting to note that he was able to acquire information about the distances in the whole of the Indo-Gangetic plains upto Gangasagara in the east and Loharani in the west, upto Kashmir, and Bhoteshar in Tibet to Kunkan and Marathadesh and Godavari in the south. Similarly, he gave a detailed description of the western coast of the sub-continent beginning from Tiz, the capital of Makran upto Tana, the capital of Kunkan. He mentions

Jīmūr, Vallabha Kānjī and Darvad without referring to the intervening distances.³⁶⁹ However, he was able to give a better account of the distance between Sarandib (Ceylon) and the mainland of India. Next he gave an account of the islands in the Indian and Chinese Seas. He had a clear concept about their situation. The islands in the west were of the Zanj while in the east which were nearer to China were Zubj or *Suvarna-dvipa* (the gold islands). In the centre were the group of islands known as Kumair of which he mentioned the *Ramm* and the Dive (Maldiva, Laccadiva) where sandy tolls appeared and disappeared, and the island of al-Wāqwāq. He mentioned their produce, explained the term Kumair, and dispels the misconceptions about it in his own time.

In these details about the regions of Kashmir and the Punjab and about the distances and directions of various regions al-Bīrūnī's account is unparalleled and surpasses earlier accounts such as that of the *Si-yu-ki* of Hiuen Tsiang in some respects. Al-Bīrūnī's rendering of Indian names is definitely superior to that of the Chinese pilgrim. As he was unable to travel to different regions of the sub-continent, his correct account deserves even greater credit especially as his stay was confined to the north-west region of the sub-continent.

However, his information about the flora and fauna of the sub-continent appears to be deficient. In respect of animals, he identified the mythical Caruda bird as a stork.³⁷⁰ He also referred to the strange details about *shrava*, an animal found in Kunkan. His detailed account how the crocodiles in the rivers of south India attack their prey is also correct. But greater details are given about *ganda* whom he identified with *kark* or *impīla* of the Negroes of Sufala.³⁷¹

As al-Bīrūnī did not believe in the helio-centric theory of the earth's movement around the sun, he was not in a position to explain fully the changes of seasons. But as a keen observer of natural phenomena he also could not ignore this problem. He and his fellow companions such as Abū Sahl Masiḥī did study the reasons behind the extreme heat and cold in the atmosphere. He wrote a *risālah* on how heat is generated in the world and the reasons for differences in seasons and crops. Abū Sahl Masiḥī wrote *Risālah fī dalālat al-lafz al-Me'ani* to explain the reasons for the extreme

cold days of winter.³⁷² He provides information about the seasons of India. He explains how the provinces situated to the north and less criss-crossed by hills get more rains. Multan did not have a regular *varshakāla*. In Kashmir it fell upto the peak of Judari, the region beyond remaining dry. In some places such as Bhatal and Indravedi it started in the month of *Ashadha* while in others in the month of *Sravana*. He had also studied the popular saying foretelling seasonal changes and found them differing from region to region.³⁷³

Solar problems are also related to astronomy and some of them, such as eclipses as described by al-Bīrūnī have been discussed earlier. The variations in day and night in different regions of the Muslim dominions often taxed the ingenuity of the scholars. Al-Bīrūnī wrote a small *risālah* explaining the duration of day and night. The Muslims thought that at the Poles a year long day occurred. This phenomenon was related by a Turk before Maḥmūd and al-Bīrūnī was able to explain it in easy terms. The above mentioned *risālah* also deals with this problem.³⁷⁴

As stated earlier, al-Bīrūnī's interest in geography probably was partly due to his urge to know other people and countries. But he was keenly interested in its astronomical or mathematical side, to such extent that it is correct to say that his main contributions lay in the realm of mathematical geography or geodesy e.g., measurement of longitudes and latitudes. He may be rightly called "the father of geodesy".

Measurement of the circumference of the earth has occupied the astronomers and geographers from the ancient times. However, the Greek and Indian astronomers were unable to measure the circumference properly.³⁷⁵ The project was too big and too expensive for any single person to undertake. Ma'mūn al-Rashīd, the 'Abbāsīd Caliph (813–33 A.D.) was deeply interested in mathematical and scientific studies. Al-Bīrūnī studied the results of these efforts.³⁷⁶ However, he found their results different from each other and, therefore, he himself undertook experiments in Jurjān and the land of the Ghuzz Turks. Repeated failures drove out the patrons. As the supply of resources dried up, the work stopped.³⁷⁷ But al-Bīrūnī's keen desire to find out the correct value remained

alive. His earlier failures and desertion by his patrons made him concentrate on cheaper and better methods to measure the circumference of the earth. Finally, he came to the conclusion that measurement with the observation of eclipses were defective due to their being indistinct and dim, while operation with straight lines was superior.³⁷⁸ Meanwhile he continued to adhere to the value of Ma'mūn's Muṣālī expedition.

Gradually, he developed a trigonometrical method which was far cheaper than the earlier methods and more accurate. This method was for the first time described in his *Kitāb fī al-Asturlāb* and he also wrote a special pamphlet, *Maqālah fī Istikhraj qadr al-'ard ba rasad inhiṭāt al-uḥāq an qalīl al-jibāl*. It is not possible to determine the period between the failure of al-Bīrūnī in his earlier attempts and formulation of the new theory and then its practical application at Nandana in India. His observations of the sun at Ghaznah occurred from May 1018 to April 1020. By that time he had little time to visit India. He refers to his measurements at Nandana in *Kitāb al-Taḥdīd* which was finished in Ghaznah on 19th September, 1024 A.D. Thus his final evaluation of the method and its practical application seems to have occurred between 1020–25 A.D. Extracts from the above mentioned books will explain his theory and its practical application properly:

To know this method is quite conceivable in imagination, and it rests on sound deductions. It is difficult to carry it out in practice only owing to the smallness of the astrolabe (or other instruments) and the little size of the thing on which we have to base our solution. And that method is this: You climb mountain situated close to the sea or a level plain, and then observe the setting of the sun and find out the dip of the horizon we have already mentioned, and then find the value of the perpendicular of the mountain. You multiply this height into the sine of the complementary angle of the dip, and divide the total by the versed sine of this dip itself. Then multiply (the double of) the quotient into 22 and divide the results of this multiplication by 7. You will get the length of the earth's circumference (in the same term or proportion) in which the



A general view of Nandana Fort

CONTOURS OF NANDANA AREA

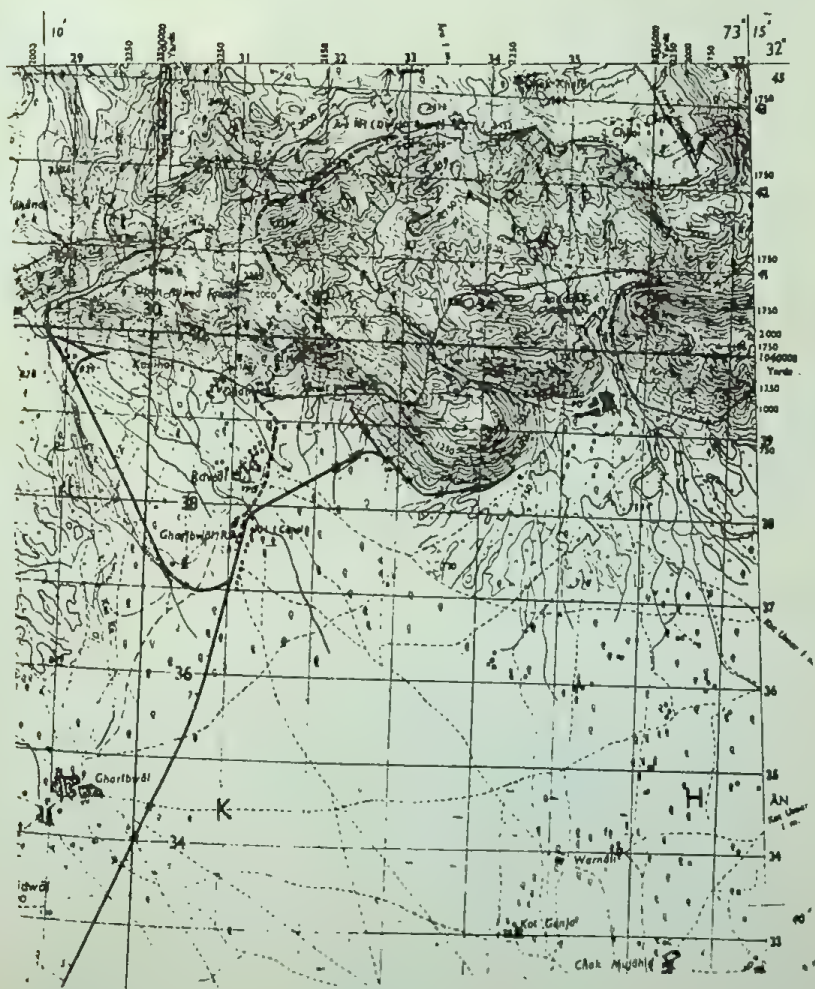
(where al-Bīrūnī had accurately measured the dimensions of earth)

Mean Grid North, in this sheet, is $2^{\circ} 45'$ East of True North.

Magnetic Variation from True North about $1\frac{1}{4}^{\circ}$ East in 1960

Scale 1" = 0.789 Mile

(Annual Change negligible)



height of the mountain has been found.

We have not so far been able to experiment with this dip, and its value in any high place. We were led to this method of Abū al-'Abbās al-Nayrīzī (d. after 912 A.D.) who states, that Eratosthenes has mentioned that the heights of the peaks of the mountains would be $5\frac{1}{2}$ miles when the length of the radius of earth is 3,200 miles approximately. For the solution of this problem it is necessary mathematically that the dip of the horizon in the mountain wherein the perpendicular is so high should be about $1/3$ degree.

Such matters, however, need actual experiments, and could be verified by testing. The Almighty wise God alone can help me (in obtaining success in such ventures).

And further:

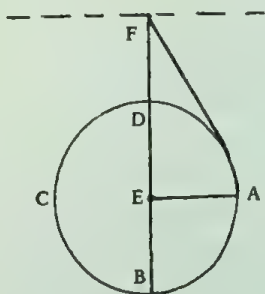
When I happened to be living in the fort of Nandana in the land of India, and I found a high mountain standing to its west, and also saw a plain to its south, it occurred to my mind that I should examine this method here...³⁷⁰

In *Qānūn al-Mas'ūdī* he stated:

My extreme anxiety to verify the matter for myself and my choosing (for this purpose) a level plain in northern Dihistan in the land of Jurjan, and eventually my failure due to exacting difficulties and want of earnest helpers in the task, led me to adopt another method for it.

When in the country of India, I found a mountain adjacent to a level faced plain, I first ascertained its height at the sea level, then imagined the sight line passing on its peak and connecting the earth with the sky, that is, the horizon. I found through my instrument that its horizon inclined from the eastern and western lines a little less than $1/3$

and $1/4$ degree. So I took the dip of the horizon as 34 minutes. I then ascertained the altitude of the mountain by taking the heights of its peak in two different places, both of which were in a line with the bottom of the mountain's perpendicular. I found it $652-1/20$ cubits. Now the mountain's perpendicular (FD) stands erect on (ABC) the earth's sphere; we carry it straight down to (DEB), which would necessarily pass through the earth's centre (E) on account of the attraction of the heavy weights to it. Now the tangent touching the earth from the peak of the mountain (F) passing to the horizon is (AF). We join (E), and (A), and thus is formed the right-angle triangle (FEA) of which the angle at (A) is known to be the right angle, and the values (of the other angles) are also known, the angle (AFE) equal to the complementary angle to the dip of the horizon, having 89° degrees and 26 minutes, with a sine of $O^{\circ}, 54', 59'', 49''', 2''$, and the angle (FEA) being equal to the dip of the horizon itself, that is $34'$ with a sine of $O^{\circ}, 35'', 36''$. And thus this triangle will also be of known sides in the proportion



in which (EF) will be sine (i.e. 90 degrees) and (EA) (half chord) will be sine for the complementary angle to the dip of the horizon. Therefore (FD) the perpendicular to the mountain (i.e. $652-1/20$ cubits) to the cubits (EA) the radius of the earth.

In this manner the radius of the earth would be 12,851, 369 cubits $50' 42''$ and the circumference, 80, 780, 039 cubits $1' 38''$, and a single one of the 360 degrees 224, 388 cubits $59' 50''$. The miles for a single degree would amount to $56^{\circ} O' 50' 6''$. This result (of mine) comes very close to the finding of those people (i.e., Al-Ma'mūn's astronomers). Nay

it actually corresponds with it, and so my mind was (at last) set at rest (and satisfied) about their reports. We have, however, used their measurements, as their instruments were more precise, and their labour to obtain it on an extremely exacting and fastidious nature...³⁸⁰

The following Table will show the work of al-Bīrūnī in relation to earlier, Mam'unid and modern findings.

| Aristotle | Eratos-thenes | Posedo-nius | Ptolemy | Aryabhata | Pulisa | Brahma Gupta | Acharya |
|--------------------------------|---------------|--|---------|---------------|--------|--------------|---------|
| 45,964 | 28,727 | 27,578 | 20,884 | 33,177 | 50,934 | 5,094 | 48,714 |
| (Figures are in English miles) | | | | | | | |
| | | Ma'mūnid | | Al-Biruni | | Modern | |
| One degree | | 366,802¼ ft. | | 363,115 ft. | | 364,150 ft. | |
| Diameter | | 397,044 ft. | | 7,878 miles | | 7,902 miles | |
| Circumference | | 25,009.31; 24, 825 225/528 miles | | 24,778½ miles | | 24,585 miles | |
| (Figures are in English miles) | | | | | | | |

In the measurement of circumference one finding of Ma'mūnid astronomers i.e., 24,825 ²²⁵/₅₂₈ miles was only 33 miles short of the actual and if the earth was taken to be a complete globe the difference would come only to 3 miles. The other finding, i.e., 25,009.31 miles was 151 miles short of the difference. Al-Bīrūnī's own figures on the basis of the measurement of diameter come to a difference of 24 miles only.³⁸¹ Taking into consideration his individual efforts and the difficulties facing him, full credit should be given to him for such an extraordinary performance.

Al-Bīrūnī's figures in *Qānūn al-Mas'ūdī* are more correct than those of *al-Tahdīd*, which demonstrates his total and persistent devotion to get correct scientific information.

One of the advantages of astronomical and geographical studies was the knowledge about the exact location of places, determination of distances, charting of ways and also finding the correct direction of *qiblah*. Al-Bīrūnī was more at home in mathematical and astronomical geography. Determination of longitudes and latitudes, therefore occupied much of his time. Nevertheless he wished to combine the

descriptive and mathematical geography. Unfortunately, his desire remained unfulfilled.³⁸²

As he was aiming to combine and co-ordinate all such knowledge he chose Ghaznah as the centre of these studies. A number of factors determined his choice of Ghaznah. He had to correlate his studies from some central point. Ghaznah with its political eminence was a suitable choice.³⁸³ However, such mundane considerations did not enter his mind. Of course they could have been present in his subconscious. His studies centred around Alexandria and Ghaznah because during his time these were the two farthest places where solar scientific observations had been recorded and that also personally by the scientists concerned i.e., Ptolemy and al-Bīrūnī. Afterwards he recorded latitudes and longitudes of more than six hundred towns, a work which surpassed that of al-Battānī not only in number of cities studied but also in respect of the vast tract of land covered.³⁸⁴

He wrote a number of treatises on this subject, while in Jurjān he had prepared an earthen hemisphere 15-cubit broad and planted site of cities and latitudes and longitudes. Unfortunately the apparatus was lost during political upheavals.³⁸⁵ Besides chapter II of the Sixth *Maqālah* in the *Qānūn* he wrote some other books on these topics only. Among such treatises on the subject, *Kitāb al-Taḥdīd Nihāyat al-amākin wa tashīḥ musāfat al-masākin*, completed in 1025 A.D., occupies an important position. *Taḥdhīb al-aqwāl fi tashīḥ al-'urūd wa al-atwāl* discusses problems and methods with regard to the correction of longitude and latitude. Correction of statements of his predecessors about longitude and latitude were attempted in *Tashīf al-Manqūl min al-'urūd wa al-ṭūl*. Another treatise deals with the fixation of the location of towns with reference to longitude and latitude. Yet another work is the *maqālah fi tashīf al-ṭūl wa al-'ard al-masākin al-ma'mūr min al-'ard*. He also discussed in a *risālah* the difference among scholars about the finding of longitudes and miles.³⁸⁶

In working out latitudes al-Bīrūnī used the elevation of the sun and the Pole Star or high and low summit of stars around the Pole Star. He was quite skilful in finding latitudes. However, the study of longitude posed certain problems. He refers to a number of methods.

1.If the latitude was known and it was combined with the observation of solar and lunar eclipse, longitude could be found. However, the time taken by the full shadow to form and the dim image preceding and following total eclipse shadow marred observations and affected the correctness of results.³⁸⁷

2.If the latitude of two places were known, observation of the passage of the moon north or south at a fixed night would give the longitude.

3.When the distances of two cities and their latitudes are known it is possible to find out their longitude.

In this way using his vast knowledge of arithmetic and trigonometry he was able to compute longitudes and latitudes and could also find their differences.³⁸⁸ In spite of his valuable and laborious contribution he admitted the possibility of slight differences and variations in his values. It appears that his latitudes were better than longitudes in whose computation great variations have been noted.³⁸⁹ His knowledge about the lands of Central Asia was better. In respect of India his knowledge was quite good. From Peshawar to Ganga Sagar the length was $13\frac{1}{2}$ degree (modern 17) and is short by $3\frac{1}{2}$ degrees only. His latitudes of Adam's bridge (9 N) and of Ceylon were correct. But as one proceeds further the variations increase. However, the latitude of Ujjan was correctly measured, but he rejected an Indian astronomer's claim of it being the middle line or Cupola of the earth from Ceylon to Mount Meru via Ujjan, Rahlat, Thaneshwar.³⁹⁰

Finding the correct direction of *qiblah* for building mosques and offering prayers was a very important problem among the Muslims. Al-Bīrūnī used it as an argument in justifying astronomical and geographical studies. As an expert astronomer his services could have been used by his contemporaries. He wrote a number of treatises on the subject. One treatise was written in the form of questions and answers, which like the *Kitāb al-Taḥḥīm* could have been meant for regular use. In another work he dwelt upon conditions which were compulsory for ascertaining the true direction. He also wrote on *Taqwīm al-qiblah* and on the correction of longitude and latitude of *qiblah* (Mecca). *Risālah fī al-ab'ūḥ al-Tashīh al-qiblah* also deals with the pre-conditions for finding

the true directions of *qiblah*. The last of his books tried to correct the errors of an earlier book. This problem was also discussed in the fifth *maqālah* of the *Qānūn*. He discusses two methods of finding the correct direction, one arithmetical and the other trigonometrical. The first method was easier, and less qualified *pesh imāms* could also make use of it.³⁹¹

Al-Bīrūnī's mastery over the measurement of the earth's circumference, diameter, and skill in finding latitudes and longitudes and computation of distance and vice versa placed him in a position to plan longitudes and latitudes of the globe and fix location of cities and countries correctly. He had started these studies at Jurjān where he had made a hemisphere of earth and planted his findings over it. Thus by comparative studies of his predecessors and his own efforts he was able to compute latitudes of six hundred cities from al-Aqṣā at the Atlantic to Khanfu (Canton) in China and from the northern plains of Central Asia upto the region of the equator. In this way he was in a position to prepare the first correct map of the inhabited world. He knew the correct position of the sub-continent as a peninsula together with Ceylon and was able to describe the situation of the three main groups of islands of the Indian ocean. The same was true of his knowledge of Central Asia and Afghanistan. The rest of his information culled from former books, though sometimes not exactly correct, gave him a general sense of direction of the Warangs, the Ice Sea etc.

Besides this gigantic mathematical effort he was able to devise methods of converting spherical figures into plane surface. His treatise *Taṣṣīḥ al-Sūr a tabṭiḥ al-kur* dealt with the above mentioned problem. This may be regarded as one of the greatest contributions of al-Bīrūnī to the science of geography. He also tried to produce spherical maps. One of his works dealt with *misāḥat* i.e., the science of measurement. *Al-Irshād alī ma vadarak Wa la Yanāl min al-Ab'ād* attempted to measure inaccessible distant objects. He had a complete command over astrolabes and their working. In the end he attempted a monumental work, *Taḥdīd al-Ma'mūrah wa Tashīḥa fī al-Ṣura* in which boundaries of countries and towns were fixed and located in maps.³⁹²

One can therefore say that by providing better information of

different regions especially about India, al-Bīrūnī added much to the descriptive geography. He also discussed the other interrelated problems and put forward theories and their explanations with a historical perspective interspersed with judicious personal observations and explanations. Nevertheless his main contribution is in the realm of mathematical geography which not only enabled him to rectify past errors and gain new knowledge, but it also enabled him to lay the scientific foundation of map-making.

These comprehensive studies speak loud of the magnitude of his labour, his immense diligence, ingenuity, and cautious improvement over the past methods and trodden grounds. For these signal accomplishments, al-Bīrūnī is now universally acknowledged as the father of geodesy.

CHAPTER VII

HUMAN SCIENCES AND SOCIETY

SOCIETY OF AL-BĪRŪNĪ'S TIME

The Muslim society of al-Bīrūnī's time was not only interested in the sciences of spirit and nature; the study of man and society also occupied its attention to the extent that although history was not regarded a part of the regular curriculum,³⁹³ its importance was generally acknowledged as a discipline widely cultivated among nations and races, eagerly sought after by all, "the men in the street" and "kings and leaders". On the surface it was considered as "no more than information about political dynasties and occurrences of the remote past events, elegantly presented and spiced with proverbs". It served "to entertain large, crowded gatherings" bringing "an understanding of human affairs; how changing conditions affected (human affairs), how certain dynasties came to occupy an ever wider space in the world, and how they enlarged themselves upon the earth until they heard the call that their time was up. But in its "inner meaning" it involved "speculation" and "an attempt to get at the truth, subtle explanation of the causes and origins of existing things and deep knowledge of the how and why of events, and had firm roots in philosophy."³⁹⁴

Such an appreciation of the science of history, its nature, aims and objectives could be possible after historical data had been collected, processed, arranged and studied. Had the position been otherwise Ibn Khaldūn could not have been in a position to study history and produce his great *chef-d'oeuvre*. These studies were initiated by an inherent urge of the Muslim society, a desire to know

about the sites and events referred to in the *Qur'ān* and details about the *siyar* and *maghāzī* of the Prophet (peace be on him) so as to have a better understanding of the religion. Very high and exacting standards were set down to evaluate the information and the reports thereby laying foundations of historical methodology on a very sound footing. Later expansion of the Caliphate and confrontation and contacts with other nations provided the Muslims with models of historiography and also placed at their disposal a vast amount of historical information. The Caliphate covering the major area of the inhabited world (*Rubā'-e-Maskūn*) and Islam claiming itself as the final universal religion created a desire to justify these claims historically. Thus, from earlier attempts in the form of books on *siyar* and *maghāzī*, translations of history books of other nations and dynastic and regional chronicles, composing of universal histories was a logical step. This development culminated in the writings of al-Ṭabari (d. 923 A.D.) and al-Mas'ūdī (d. 957 A.D.).³⁹⁵

In this way, by the end of the tenth century A.D. history writing was a highly cultivated art. However, it suffered from some basic defects. To some extent it was still an interesting form of writing for entertainment, spiced with proverbs and anecdotes. Its chronological order did not provide a better appreciation to topical or regional trends of evolution. It mainly dealt with the chronicles of kings and dynasties, their wars and policies. However, there were some exceptions such as Miskawayh and al-Bīrūnī, who deviated from the beaten path and tried to write about the people, their life and beliefs. There were other scholars like 'Abd al-Latīf Baghdādī and Shahrastānī who devoted their attention to the study of comparative religion. Al-Bīrūnī's studies combined historical, scientific and religious information of people. His approach was more analytical, more comprehensive and gave a fuller and better picture of ancient societies. *Kitāb al-Hind* is the best example of such a style. Al-Bīrūnī was different from his contemporary historians in another respect also. He had adopted Arabic for the exposition of his theories and works because it was a better vehicle for conveying correct meaning. He was not a writer who enjoyed playing with words indulging in the nuances of language. His

scientific training had made him a simple but selective writer. He was also aware that while dealing with matters foreign to one's language and beliefs one should be careful in the use of words.³⁹⁶

Al-Bīrūnī's excursions into the historical and sociological fields gave rise to the following works:

1. *The Chronology of Ancient Nations* was written at the request of a scholar and completed under the patronage of Washmgīr Shams al-Ma'ālī. Most of it was probably completed by the end of the first millennium of the Christian era. However, al-Bīrūnī mentioned it among his incomplete books in 1035 A.D. Probably Chapter VIII of the book dealing with the heterodox and syncretic sects needed finishing touches, for al-Bīrūnī got *Kitāb Safar al-Isrār* of Mānī after a search of forty years. Incidentally the same chapter is missing from the extant manuscripts.
2. *Masāmīr al-Khwārizm* dealt with the annals of Khwārizm. It included a first person account of the tragic happenings marking the end of the Ma'mūnid princes. His eye-witness account 'quoted extensively by Bayhaqī' dispels a number of romantic but apocryphal stories woven round some episodes. Unfortunately, the work is lost.
3. Another interesting work was the history of the heterodox sects of the Qarāmītah called *Kitāb al-Akhlbār al-Qarāmītah wa'al Mubayyadah*. This work also is not extant. It was written earlier than the *Chronology*. In view of al-Bīrūnī's extreme care to uphold the truth above everything else this account from a contemporary writer would have been interesting. Al-Bīrūnī as a keen observer of political events and forces of history was aware of the emerging influences in his age, e.g., the rise of the Ismā'īlīs, the Qarāmītah, and the emergence of the Turks.

One of his treatises discussed the dangers inherent in the rise of the Turks. It might not have been a book of history in the pure sense of the term; nevertheless, it could have thrown interesting light on the Turkish question from the point of view of non-Turks.

4. It is said that al-Bīrūnī also wrote a book (no longer extant) on the reign of Maḥmūd of Ghaznah. As there is no reference or indication to the fact that it was written at the behest of the Sultan or his sons, it may be presumed that al-Bīrūnī wrote the book on

his own accord. The date of its composition and its contents cannot be ascertained, as it is also untraceable. The fact that he wrote a history of Maḥmūd goes to disprove the allegations of bad relations between the Sultan and the great scholar.

5. At the time of Maḥmūd's death al-Bīrūnī had just completed his other masterpiece, *Kitāb fī Taḥqīq mā al-Hind min maqbūlah wa mardhūlah* (*Kitāb al-Hind*), a compendium of concise and penetrating information about the socio-economic and political conditions obtaining in the sub-continent together with information pertaining to various Indian sciences and beliefs.

In this way al-Bīrūnī specialised in the history of Khwārizm and Ghaznah and in the beliefs and cultures of non-Islamic nations. With his immense capacity of hard work and ability to marshal and evaluate data, he could have written universal history. But his interest was mainly confined to astronomy and mathematics. Moreover, there was no external stimulus as happened in the case of the *Chronology* and *al-Hind* when requests by scholars persuaded al-Bīrūnī to commit his knowledge to writing.³⁹⁷

A better appreciation of al-Bīrūnī will be possible after an evaluation of his contribution, aim, and methodology. In his preface to the *Āthār al-Bāqiyah*, (the *Chronology*), al-Bīrūnī emphasised the importance of the *akhbār wa rawāyāt* (information, news and traditions) of past nations, for such knowledge throws light on their residuary customs.³⁹⁸ As a staunch believer in truth he wanted to follow the holy injunction to "speak the truth, even if it were against yourselves"³⁹⁹ and thought that one should not mind the fury of kings in speaking the truth before them.⁴⁰⁰ When Sultan Maḥmūd showed him the renowned opaque ruby from Mathura, al-Bīrūnī adjudged it unworthy of the exaggerated notions of value associated with it.⁴⁰¹ In the field of historiography as well he frankly and fearlessly distinguished between the worthy and unworthy rubies. He was aware of the limitations of his own knowledge and of the difficulties accompanying translation or description of foreign beliefs, customs and sciences. Therefore, he adopted the attitude of a correct reporter of facts, and evaluated them for their probability and genuineness so that the seeker of truth and wisdom (*hikmat*) might be enabled to do research and

study on those aspects of information which were not available to him.⁴⁰²

Al-Bīrūnī was a voracious reader and a very painstaking seeker of truth. He had full command over all the historical literature available in the Muslim world,⁴⁰³ i.e., some idea of Greek and Byzantine history such as the birth and life of Alexander,⁴⁰⁴ details about the pagan Arabs, history of Syria,⁴⁰⁵ Iran, Central Asia and some information about the political conditions in the regions of the sub-continent. He also knew the *Old and New Testament* and the difference between the Christian and Jewish versions. He had studied *Torah*, the *Book of Sedler Olam* and *Tetragrammaton* of the Jews. He was acquainted with book of Hermes of the Sabaeans.⁴⁰⁶ However, his study of Manichaeism was quite extensive probably because he was able to contact them in Central Asia. He referred to *Shāh Purqān*, *Gospel*, *The Sauras*, the *Book of Giants*, the *Book of Books* and the *Books of Mysteries*, *Safar al-Isrār* of Mānī and the *Book of Marriage* by one of the Manichaean missionaries.⁴⁰⁷ His other source for these sects was the book of Abū al-'Abbās al-Īran Shahrī.⁴⁰⁸ The above discussion clearly demonstrates the extensive and intensive studies carried on by the great scholar.

Besides these books, the travellers and persons who have been to different places provided him with relevant and interesting information. Whenever he used hearsay information he checked it by cross-examining the reporter and after ascertaining the truth he used to put "it down in writing instead of trusting his memory", as he "was not sure of safety, and as a guard against any accidents."⁴⁰⁹ These precautions were necessitated by the weaknesses inherent in the evidence available and in individual character. Al-Bīrūnī was fully aware of his own shortcomings and the failing of others and knew how to differentiate between different forms of evidence and what measures to adopt. To quote his own words:

No one will deny that in questions of historic authenticity hearsay does not equal eye-witness.

He evaluated the merits and demerits of these forms of evidence thus:

The object of eye-witness can only be actually momentary existence, whilst hearsay comprehends alike the present, the past and the future, so as to apply in a certain sense both to that which is and to that which is not (i.e., which either has ceased to exist or has not yet come into existence). Written tradition is one of the species of hearsay... we might also say, the most preferable. How could we know the history of nations but for the everlasting monuments of the pen?

He argues:

The tradition regarding an event which in itself does not contradict either logical or physical laws, will invariably depend for its character as true or false upon the character of the reporters, who are moved by the divergency of interests and all kinds of animosities and antipathies between the various nations. We must distinguish different classes of reporters.^{4 10}

People lie to further their personal, family, sectarian or national interests, to favour their friends or patrons or to gain some profit. Some lie from ignorance, following others blindly. If reporters of this kind become so numerous as to represent a certain body of tradition, or if in the course of time they even come to form a consecutive series of communities or nations, both the first reporter and his followers form the connecting links between the hearer and the inventor of the lie and if the connecting links are eliminated, there remains the originator of the story, one of the various kinds of liars..., as the only person with whom we have to deal.

That man only is praiseworthy who shrinks from a lie and always adheres to the truth, enjoying credit even among liars, not to mention others. He is truly courageous who is not only ready to die bravely in action but possesses the genus of courage i.e., to scorn death, whether by word or deed. Truthfulness enjoined by the holy scriptures on mankind

possesses its own intrinsic beauty just like justice, while liars give birth to all kinds of vices which serve to ruin the world and mankind.⁴¹¹

This brilliant exposition of the ideal of historiographer or a scholar in general was penned at an advanced age. Another great trait of al-Bīrūnī was his consistency of beliefs. He had formed the impartial attitude of a true historian at an early age as is manifest from his preface to the *Chronology* where he enumerated conditions for correct presentation of alien beliefs and cultures.

He conceded that correct information on the basis of opinions and thoughts of the nations rather than reasoning should form the basis of inquiry. These facts and thoughts should be acquired from the persons holding them and believing in them and not from some secondary sources. The acquired information should be compared with the available one. A prerequisite for such a scholar was that he ought to be free from all bias and prejudices, selfish interests, ideas of profiteering and from the complexes of a conqueror. A historian should free himself from all such associations and drawbacks which inhibit him from observing the truth. The above mentioned defects and xenophobia was not confined to the Hindus and Muslims of his age but was common to all the nations towards one another.⁴¹² The myths and traditions of those people should be regarded as lying in the realm of probability. As it was difficult, nay impossible, to comprehend the history of all nations within one's lifetime, the best course open was to deduce the least known or unknown from the well-known and the distant from the nearest (most accessible), and to eke out the correct versions of traditions from the people concerned and after careful comparison and correction in the light of logical probability in evidence present it in the most correct manner.⁴¹³ On this basis he was ready to accept the traditions of longevity and bigger bodies during the Prophet Abrāhām's period on the basis of the persistency of such reports and also due to the realization that age and body were relative to the times. Such things could also be freaks of nature. However, certain sections of people blindly rejected these traditions.⁴¹⁴ Thus, according to him a true historian "will do his

utmost to deduce the tenets of a sect from their legendary lore, things which people tell him, pleasant enough to listen to, but which he would never dream of taking for true or believing”.

As has been stated earlier, his care in the correct presentation of alien beliefs left him little choice for indulging in the traditional, ornate, and elaborate rhetorical style. In treatment of the subject matter he also followed certain patterns. He arranged his data logically and geometrically. He never referred to any new subject, fact or person unless he had mentioned it or him earlier.⁴¹⁵ In *India* the chapters generally open with a precis of the problem followed by a detailed exposition profusely interspersed with extensive quotations from original Sanskrit works, now generally accepted as true. In the end he tried to explain the strangeness of these beliefs by comparing them with one another. Excluding Sufistic ideas he never confronted pagan ideas with the tenets of Islam mainly because the two groups were diametrically opposed to each other and he regarded Islam as the absolute truth. Absolute truth cannot be compared with its antithesis:

The heathen Greeks, before the rise of Christianity, held much the same opinions as the Hindus... Therefore, I like to confront the theories of one nation with those of the other simply on account of their close relationship, not in order to correct them. For that which is not the truth does not admit of any correction, and all heathenism, whether Greek or Indian, is in its path a narrow one and the same belief, because it is a deviation from the truth.⁴¹⁶

He also uses discursive style of writing and sometimes digresses to some other subject in his discussions, not for the sake of increasing the bulk of the books but to avoid dullness for the reader. “For a change from one subject to the other is like visiting different gardens; every new garden attracts reader’s attention”.⁴¹⁷ The method was found in all his works particularly those dealing with socio-cultural studies. However, these digressions also follow the geometric method and occur with reference to some earlier reference. In the *India* while discussing distances when he comes

to Kunkan he refers to *sharava* and then passes on to the description of *ganda* (rhinoceros) and crocodiles and after this "digression", he returns to his "subject" i.e., distances between the cities of India.⁴¹⁸

A sound training in geo-physical conditions and an understanding of the interdependence of history on geography are the prerequisites of a good historian. Al-Bīrūnī presented a fortunate combination of these qualities with a true scientific spirit and attitude. He knew how extreme cold in the northern regions prevented inhabitation.⁴¹⁹

He discussed the traditional *aqālīms* and preferred geo-physical divisions.⁴²⁰ He was aware how nature allows species to develop and evolve and was cognizant of the part played by the ratio of population growth and survival. He argues: "The life of the world depends upon sowing and procreating. Both processes increase in the course of time, and this increase is unlimited, whilst the world is limited." Here he showed a wonderful vision and a sense of historical perspective and evolution in time and space.

He adds:

When a class of plants or animals does not increase any more in its structure, and its peculiar kind is established as a species of its own, when each individual of it does not simply come into existence once and perish, but besides, procreates a being like itself or several together, and not only once but several times, then this will, as a single species of plants or animals, occupy the earth and spread itself and its kind over as much territory as it can find. The agriculturist selects his corn, letting grow as much as he requires, and tearing out the remainder. The forester leaves those branches which he perceives to be excellent, whilst he cuts away all others. The bees kill those of their kind who only eat, but do not work in their bee-hive.

Nature proceeds in a similar way; however, it does not distinguish, for its action under all circumstances is one and the same. It allows the leaves and the fruits of the trees to perish, thus preventing them from realising that result which

they are intended to produce in the economy of nature. It removes them so as to make room for others.

If thus the earth is ruined, or is near to be ruined, by having too many inhabitants, its Ruler... for its has a Ruler and his all embracing care is apparent in every single particle of it... sends a messenger for the purpose of reducing the too great number and cutting away all that is evil.⁴²¹

Though al-Bīrūnī did not compose any universal history so as to open his book with the origin of men yet he was fully conversant with the topic. He had written a hundred-sheet supplement to the collection of stories about the origin and end of the world. He also discussed the stories of the Jews, the Christians and the Majūsīs (Magians) about the origin of man. He again returned to his topic in his book *al-Taḥdīd* and gave a thorough and detailed discussion.⁴²² He regarded the Universe as non-eternal and the age of the earth as millions of years. Regarding the first human beings he found that the *Qur'ān* does not enter upon the question.⁴²³

He found the books of the Jews, the Christians, the Sabians and Majūsīs speaking of the first man, but differing widely from each other. Passage of time had corrupted them and it was better to accept only that account which fulfils conditions of truth and element of probability. The case of the Jews who went through repeated trials, turmoils and upheavals was most typical. It was therefore not strange that they were unable to keep their dates and history straight.⁴²⁴

Al-Bīrūnī concurred with the Greeks that natural cataclysms stripped regions of their inhabitants; "but when after a while after the disaster and its consequences have passed away, the country begins to recover and show new signs of life, then different people flock there together like wild animals, who formerly were dwelling in hidden recesses, caves and on the tops of the mountains. They become civilised by assisting each other against common foes, wild beast or men, and furthering each other in the hope for a life

in safety and joy. Thus they achieve great numbers; but their ambition, circling round them with wings of wrath and envy, begins to disturb the serene bliss of their life.

Some time a nation of such a kind derives its pedigree from a person who first settled in the place or distinguished himself by something, so that he alone continues to live in the recollection of succeeding generations, whilst all others besides him are forgotten.^{114 2 5}

Al-Bīrūnī also discusses the origin of castes in society:

If a new order of things in political or social life is created by a man naturally ambitious of ruling, who by his character and capacity really deserves to be a ruler, a man of firm convictions and unshaken determination, who even in times of reverses is supported by good luck, insofar as people then side with him in recognition of former merits of his, such an order is likely to become consolidated among those from whom it was created and to continue as firm as the deeply rooted mountains. It will remain among them as a generally recognised rule in all generations through the course of time and the flight of ages. If, then, this new form of state or society rests in some degrees on religion, these twins, state and religion, are in perfect harmony, and their union represents the highest development of human society, all that man can possibly desire.

He explains how ancient kings (not Divine ordinance) kept their subjects divided. By way of illustrations he refers to the caste systems of Iran and India.^{4 2 6}

All institutions of this kind are like a pedigree, as long as their origin is remembered; but when once their origin has been forgotten, they become, as it were, the stable property of the whole nation, nobody any more questioning its origin. And forgetting is the necessary result of any long period of time, of a long succession of centuries and generations.

Although al-Bīrūnī's main works of history i.e. *Masāmīr al-Khwārizm* and the history of Mahmūd's reign are lost and only his two socio-cultural and anthropological studies e.g., the *Chronology* and the *India* have survived, yet valuable historical information, abounds, scattered in his various works.

Some interesting references occur in the *India*. He asserts that before the Turks no other Muslim had advanced towards India beyond Kabul.⁴²⁷ How misleading notions had spread about Islam among the non-Muslims at such an early date is very well illustrated by the anecdote of the *asfahbad* (ruler) of Kabul who on the eve of his conversion to Islam claimed exemption from beef and sodomy.⁴²⁸ An interesting episode relates to the conflict between statecraft and Islamic ethics. 'Add al-Dawlah (949-83) of the Buwayhids in order to save the honour of his subjects from his soldiers allowed prostitution of women.⁴²⁹ Al-Bīrūnī also provided interesting comparison between *tasawwuf* and the Greek and Indian thought.⁴³⁰

In the same way some light is thrown by al-Bīrūnī in the other fields of history. After recounting the history of Alexander he went on to explain the origin of the Alexandrian era and pointed out that it began ten years after the great conqueror's death. His work on calendars of different nations and how to find out one date from another exhaustively dealt in the *Chronology*, and about Hindu eras in the *India*, for the first time established the time elapsed between different calendars.⁴³¹ In the light of his studies it would be possible to determine the date of different events of different nations and thereby allow a comparative universal study possible.

He also pointed out two important developments in the pre-Islamic period. A conflict between Magianism and Buddhism had spread upto Mosul and northern frontiers of Syria. Thus before the Hellenistic "drift" the Middle East had come under the influence of the Indian culture. It seems that a local reaction occurred and Zartusht, the apostle of a new religion, with the help of Gushtāsp (probably Hystaspes) drove out the Buddhists who under this stimulation entered Central Asia. Later Mānī when driven out

by persecution also went to India and learnt the doctrine of metempsychosis.⁴³²

However, his most important contribution was to the history and knowledge of India. He was the first Muslim writer to refer to the pre-Muslim rulers of Kabul and Kashmir. It is said that the early rulers of Kabul were Turks of Tibetan origin. Their ancestor was Barhetkin who claimed divine and miraculous birth. He became king with the title of *Shāhiya* of Kabul. His successors were said to be sixty. However, little information was available about their chronological order and identity. But it seems that perhaps al-Bīrūnī was referring to the Kushans who came to the Trans-Hindukush region from Tibet and claimed divine origin. The most illustrious member of this house was Kanik (Kanishka) who built the *vihara* of Puruṣhāwar. It was called after him, *Kanik-haytya*.⁴³³

Then follows an account of his successful expedition against the ruler of Qannawj. The last ruler of this dynasty was Lagaturman. He was a tyrant and was forcibly removed by his Brahman *wazir*, Kallar, who founded a new dynasty.⁴³⁴

The new dynasty had the following princes Kallar, Sāmānel (Samanla), Kamāhī, Bhīm (Bhīmā), Jayval (Jayapala), Anandapala, Tarojanpala (Trilochanpāla, d. 1021) and Bhūmpāla (d. 1026). The account given by Kalhana and the numismatic evidence corroborate the account given by al-Bīrūnī except that Kallar has been called Lalliya and that Samant (also Samantadeva) belonged to the Turkish house and regained his family throne for some time. However, the Kashmiri princes combining with Kamal (also Kamaluka) crushed the Turkish dynasty finally. It also explains the flight of the Hindū *Shāhiya* princes after being defeated by Mahmūd to Kashmir whose rulers were their distant relations. Al-Bīrūnī mentioned an interesting episode of Anandapala. Having come to know that the Turks were troubling Mahmūd, he offered military help: "In acting thus, I (Anandapala) do not speculate on the impression which this will make on you. I have been conquered by you, and therefore I do not wish that another man should conquer you."

Though Anandapala and his dynasty were inimical towards the Muslims yet according to al-Bīrūnī "in all their grandeur, they

never slackened in doing that which is good and right, and that they were men of noble sentiments and noble bearing". At another place al-Bīrūnī stated how in order to please his teacher whose book on grammar was rejected by the Kashmiri scholars, Anandapala conquered Kashmir. However, Mahmūd and al-Bīrūnī did not find Kashmir under the Hindū Shāhiya but divided into small kingdoms whose ruler Sangrām Rajah had helped Trilochanpāla. Thus if Anandapala attacked Kashmir he might have had returned after accepting a nominal allegiance by the ruler of the south-east region where Hindu chiefs ruled. For Kashmir's Sangrām Rajah with the help of inclement weather and strong forts defied the two attacks of Mahmūd of Ghaznah.

As described earlier, the south and east of Kashmir belonged to Hindū chiefs but in the west there were a number of other chiefs e.g., the Bolar-Shāh and the Shugnan-Shāh while the "remote parts upto the frontiers of Badakhshan belonged to Wakhan-Shāh". In the north and east were the Turks of Khoten and Tibet. In the north in the mountains of Bolar and Shamilan dwelt the Turkish tribes called Bhattavaryan whose chief was styled Bhatta-Shāh. Their towns were Gilgit, Aswira and Shiltas and their language was Turkish. They were a menace to Kashmir proper. Addishtan was the capital of Kashmir.

The country around Qannawj was still known as *Madhyadesha*. The frontiers between Sind and kingdom of Qannawj were traditionally similar. After Qannawj eastward was the empire of Shilahat on its right was the country of Tilwat. East of Tilwat was Nepal and Tibet. South-east of Qannawj was Jajāhūlī whose capital was Khajurahu. In between were Gwalior and Kalinjar. Bazna called Narayan by the Muslims, was the capital of Guzarat. Later, on Bazna's decay, people migrated to Jadūra.⁴³⁵ South of Guzarat was situated Maiwar with its capital Jattaur (Chittor).⁴³⁶ Adjacent to it was Malwa and its capital Dhār.⁴³⁷ South of Dhār were the regions of Mahratta Desh and the province of Kunkan whose capital was Tāna.⁴³⁸ South-west of Bazna were Lārdes̤h with its two capitals Bihroj and Rihanjūr on Bhatti and Aror, Bamhanwa, Almanṣūra and Lohārānī. Incidentally this was the first

reference to Lohārānī. After this description, with Qannawj and Bazna as centres for determining distances, he began to describe the coastline from Tiz, the capital of Mukran, to Kachchh, Somnath and Tāna. Next to Tāna (Kunkan) came the country 'of Lārān, then Vallabha, Kānji, Dawad, Singaldib and opposite to it Ummalnāra and Rameshwaram.⁴³⁹ In these references he clearly established the situation of towns and countries in relation to each other. He also described the situation of al-Daibul and Lohārānī, the two seaports of Sind, one decadent and the other just emerging. With the help of his distances and directions a political map of north India and south India including its western coast and regions upto Godavari may be drawn.

Besides this contemporary data, al-Bīrūnī also provided some valuable information about India's past history. About the Indus valley region two important references occur, both of them relating to Multan. He categorically stated that Jalam bin Shaybān, the founder of Ismā'īlī rule in Multan, destroyed the remains of the old temple of the sun. It shows the iconoclastic zeal of the Ismā'īlī *dā'ī*.⁴⁴⁰ In their attempts to win popular support they could have posed as champions of pure Islam. Still a sacred pond at Multan remained where the Hindus tried to bathe in spite of restrictions imposed by the government.⁴⁴¹ At first the people of Multan used to follow the calendar prevalent in Sind but by the time of al-Bīrūnī they had come under the influence of Kashmir and had adopted the Kashmiri calendar. The Hindus after the destruction of their sacred place in Multan also used to visit Kashmir.⁴⁴² Similarly the centres of learning had shifted to Kashmir and Benares.⁴⁴³ Therefore, it may be said that in Western India, Kashmir had become the champion of orthodox Hindu reaction against the expansion of Islam. It tried to ward off the onslaught by a typical defensive posture i.e., by limiting contacts with foreigners as much as possible.⁴⁴⁴

Al-Bīrūnī also quoted Indian reaction against the Sakas who oppressed people between the Indus and the ocean and tried to convert the Hindus to their belief.⁴⁴⁵ In other words, the Sakas most likely compelled their subjects to accept Hellenistic culture which they had brought with them from Central Asia. To some

the Saka ruler was a Sudra either from al-Manṣūrah, a region later defiled in their eyes by the Muslims, or had come from the west. Finally Vikramaditya coming from the east defeated and killed him near Multan.⁴⁴⁶ Al-Bīrūnī stated that different *Sampats* (calendars) were popular in different regions, *Harṣhakāla* in Mathura and Qannawj, and Vikramaditya's in the south-west. In the Vallabhi State they used Vallabha. While referring to *Guptakāla* it was mentioned that the Guptas were a very wicked and powerful people.⁴⁴⁷

The greatest obstacle which prevented any rapport between Hindus and Muslims was the institution of *Varna* (colours, castes). For, in the words of al-Bīrūnī, "we Muslims, of course, stand entirely on the other side of the question, considering all men as equal, except in piety."⁴⁴⁸ He described the origin and difference of the four castes.⁴⁴⁹ However, he discerned that the Vaisya and the Sudra were closer to each other and easily inter-mixed with each other. Besides these four castes al-Bīrūnī referred to two other groups of castes. Styled *Antyaja* they were, in fact, non-caste professional groups. However, they were divided into eight groups, e.g., fuller, shoemaker, weaver, juggler, basket and shield maker, sailor, fisherman and hunter of wild animals and birds. They lived outside villages and towns. Among them also there were distinctions. The rest of the *Antyaja* groups did not marry with the fuller, shoemaker and weaver. Besides these eight groups there were the people called Hādi, Doma (Dinba), Candala (*Chandala*) and Badhatau who were not reckoned amongst any caste or guild. They were occupied with menial work, like the cleansing of the villages and other services. They were considered as one sole class, and distinguished only by their occupations. In fact, they were looked upon like illegitimate children; for according to general opinion 'they descend from a Sudra father and a Brahmani mother as the children of fornication; therefore they are degraded outcasts'.

He gave details about the life of the Brahmans, their two main groups of the *Agnihotras* and *Dikṣhats*, their four periods of life and practices. In the same way he dealt with the other castes. The duties of Brahmans were piety, giving alms and receiving them.

They learned and taught *Vedas*. They could not be condemned to death. Five vegetables, onions, garlic, a kind of gourd, the root of *krnen* and *nali* were taboos for them. The Kshatriya read the Veda and learned it, but did not teach it and acted according to the rules of the *puranas* as fighters. The Vaishya were the agriculturists and cattle-breeders. The Shudras were servants and were debarred from reciting the *Vedas*.⁴⁵⁰

Among the Anatiya, the Hādīs did not eat anything unclean and were regarded as the best among their group. Next came Doma, who were musicians and singers. The other lower classes practised killing animals and served as hangmen. Badhatau, who devoured dead animals and dogs etc., were at the lowest rung of the caste ladder.⁴⁵¹

All other men except the *Chandāla* were regarded as *mēlechhcha*, i.e., unclean, killer of men and animals and eaters of cow. Al-Bīrūnī realized that "all these things originate in the difference of the classes or castes, one set of people treating the others as fools".⁴⁵²

Al-Bīrūnī was told that Vasudeva had said: "If to the eyes of intelligence all things are equal, to ignorance they appear as separated and different." However, such idealistic strains and the two quotations from *Bhagvad Gita* are untraceable in the extant versions of the poem. If there were such ideas present which militated against the concept of inequality they were later weeded out, or some informant of al-Bīrūnī might have tried to justify his religion in the eyes of the Muslim sage by harping upon the theme of differences in the religion of the intelligent and the ignorant.⁴⁵³

Discussing the food habits of the Hindus, Al-Bīrūnī stated⁴⁵⁴ that "originally, killing in general was forbidden to them, as it is to the Christians and Manichaens. However, in practice it was limited to the Brahmans only. Meat of sheep, goats, gazelles, hares, rhinoceros, buffaloes, fish, water and land birds, as sparrows, ring doves, francollins, doves, peacocks, and other animals which were not loathsome to man nor noxious were allowed. While cows, horses, mules asses, camels, elephants, tame poultry, crows, parrots, nightingles, all kinds of eggs and wine were forbidden. After

describing the early Hindu traditions of eating of flesh of cows and its subsequent sanctity he thought that probably economic reasons were the main motivating force just as in the case of Hajjaj bin Yusuf's ban on cow slaughter in the region of Babylonia.

In the field of matrimonial ceremonies as well the information received by al-Bīrūnī did not seem to reflect the true picture obtaining in India. Early marriages were in vogue. "There is no reference to dowry", says he, "no gift is settled between them. The man gives only a present to the wife, as he thinks fit, and a marriage gift in advance, which he has no right to claim back, but the wife may give it back to him of her own will." Only four marriages were allowed. Some thought the number of wives was relative to caste in the ratio of 4,3,2,1, in a descending scale from the Brahmans.⁴⁵⁵ The limit of four wives appears to be either due to the influence of Islam or to justify the Indian system as the best in the world. Another interesting fact was that the caste of a child was determined by the caste of the mother.⁴⁵⁶ The rest of the customs, viz., maltreatment of women, *sati* etc., were truly depicted by him. He found that harlotry was not considered as forbidden.⁴⁵⁷ Al-Bīrūnī again tried to explain this practice as a necessary evil having roots in economic and political factors. Speaking of justice and punishment he says: "In this regard the manners and customs of the Hindus resemble those of the Christians... based on the principles of virtue and abstinence from wickedness, or in other words, on non-violence."

However, al-Bīrūnī regarded such an idealistic attitude commendable but impracticable. A number of methods were used to find the guilty. A decision could be reached by one of the contestants agreeing to take an oath. There were ordeals by drowning, by boiling water and finally by red hot iron. The thieves were sometimes severely punished, fined or let off after facing ridicule. Adulterers were banished. The Brahmans could not be punished with death.⁴⁵⁸

As the rule governing inheritance fell within the field of study of a mathematician like al-Bīrūnī he paid special attention to it. He found that women did not inherit except the daughter who received only one fourth part. The descendants had the better claim than any other relations.⁴⁵⁹

Describing the manners of Hindus, al-Bīrūnī says: "We shall speak of certain strange manners and customs of Hindus. The strangeness of a thing evidently rests on the fact that it occurs but rarely, and that we seldom have the opportunity of witnessing it. If such strangeness reaches a high degree, the thing becomes a curiosity, or even something like a miracle, which is no longer in accordance with the ordinary laws of nature, and which seems chimerical as long as it has not been witnessed. Many Hindu customs differ from those of our country and of our time to such a degree as to appear to us simply monstrous. One might also think that they had intentionally changed them into the opposite..."⁴⁶⁰

The Hindus did not cut their hair of the body. They ate singly and drank wine before eating and their teeth were red due to the chewing of betel leaf. In their dress some wore a two finger broad loincloth bound with two cords or wore large trousers whose strings were at the back. They used *sidar* and *kurtakas*. On festival days, they besmeared their bodies with cowdung. The men wore articles of female dress and used cosmetics, ear-rings, armlets, golden seal-ringers on fingers and toes. They consulted their women. They did not hesitate in spitting and blowing their noses in assemblies.⁴⁶¹

In their games he referred to the game of chess which could be played by four persons with eight pieces and played with a pair

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| T | H | E | K | | | P | T |
| P | P | P | P | | | P | H |
| | | | | | | P | E |
| | | | | | | P | K |
| K | P | | | | | | |
| E | P | | | | | | |
| H | P | | | P | P | P | P |
| T | P | | | K | E | H | T |

K for King, E for Elephant (Bishop), H for Horse (Knight), T for Tower (Rook), P for Paidal (Pawn)

a dice.⁴⁶²

About the script and literature of the Hindus, al-Bīrūnī says: "The tongue communicates the thought of the speaker to the hearer. Its action has, therefore, as it were, a momentary life only, and it would have been impossible to deliver by oral tradition the accounts of the events of the past to later generations, more particularly if they are separated from them by long periods of time. This has become possible only by a new discovery of the human mind, the art of writing, which spreads news over space as the minds spread, and over time as the spirits of the deceased spread. Praise therefore be unto Him who has created every thing for the best."⁴⁶³

He discusses various materials used in writing. In India the people of central northern regions used the bark of *tūz* tree and called it *bhurja*. Pieces of this bark, one yard long and as broad as the outstretched fingers of the hand, were oiled and polished for making them hard and smooth. Such leaves of a book properly marked were wrapped up in a piece of cloth and fastened between two tablets of the same size. Such a book was called *pūthī*. In south India they used the leaves called *tārī* of a slender palm-like tree (*Borassus flabelliformis*), also one yard long and three fingers broad.⁴⁶⁴

The script consisted of 50 alphabets written from the left below the line, each alphabet separate from each other. The vowels were represented by different signs. He also reported unfamiliar consonants and that it was difficult for the Muslims to distinguish between many a cognate pair of them.⁴⁶⁵

Al-Bīrūnī was fortunately able to collect information about the number and names of scripts prevalent in the sub-continent.

Sidha matrika was the most extensive form of script in use. Its sphere of influence included Kashmir, Madhyadesh (today's Uttar Pradesh) and Varanasi (Benares). Tradition attributed its origin to Kashmir. Kashmir was the place where according to another tradition the Vedas were first rendered into writing. Kashmir and Varanasi were the two "high schools" of Hindu and Sanskrit learning. Thus one may surmise that he was probably referring to the script of the Sanskrit prevalent in those regions.⁴⁶⁶

In the region of Malva there was another script *Nāgara* differing from the former only in the shape of the characters.

The above two scripts combined together to produce *Ardhanāgari* i.e., half *nāgra* which was used in Bhattiya and some parts of Sindb (probably Upper Sind).⁴⁶⁷

In this way the major part of north India was under the influence of *Sidha matrika* and its various forms. It seems that a conflict was going on between the *Sidha matrika* and *Nāgara* (*Nāgri*) in which eventually *Nāgri* won the day probably helped by a decay in Sanskrit learning, and the Muslim conquest. Reference to Bhattiya and Upper Sind may mean that culturally the region adjacent to Multan had become linked up with that of Kashmir and north India, rather than Sind or more correctly it was so much influenced by the north Indian culture that it gave birth to a mixed script, a certain indicator of the multiple socio-cultural forces at work in this middle region of the Indus basin (Pakistan), the *Sira'iki* speaking region of today.

However, the region of Sind was further sub-divided into two sub-cultural units. Lower Sind towards the sea coast with the region of Malwashan(?) used the Malwari alphabets, while the region of Central Sind (Bahmanwa or Almarṣūrah) used the *Saindhava*. Earlier in the 10th century Arab travellers had found the Arabic and Sindhi being spoken in Manṣūrah.⁴⁶⁸ Al-Bīrūnī's reference to a definite Sindhi script means that the *naskh* script was not in use.

There were other alphabets and scripts in use e.g., *Karnata* in Karnatadesha; the *Andhri* in Andhradesha; the *Dirwari* (Dravidi) in Dirwaradesha, the *Lari* in Laradesha; the *Gauri* (Gandi) used in Purvadesha, i.e., the eastern country (Bengal) and the *Bhaykshuki*, used in Udunpur in Purvadesha. It was the writing of Buddha.⁴⁶⁹

Multiplicity of the scripts signifying the emergence of local and regional languages and the prevalence of literary and scholarly works of the 8th century A.D. e.g., Brahmagupta reflect the decaying condition of learning in the sub-continent in the 11th century.⁴⁷⁰ The Muslim conquest of the Indus basin made the Hindu learning retreat to Kashmir and Benares. It also led to the development of an extreme isolationist outlook, more prominent in the case of Kashmir. The Hindu was proud and aloof and unlike some of his predecessors was not ready to accept the

supremacy of foreigners and learn from them. Coupled with it was the failure of the Indians to learn paper-making. Their material for writing was not easy to prepare and, therefore, it was a highly difficult task to acquire their books though people like al-Bīrūnī were ready to spare neither cash nor labour for them.⁴⁷¹

The Indian antipathy towards foreigners, in general, and towards Muslims, in particular, precluded any contacts. They were not ready to share their knowledge. However, even they could not withstand the persistent probing of the scholars from Ghaznah. Al-Bīrūnī was able to know by hearsay and study the salient features of their sciences and literature and has provided us a review of their learning in a clear and lucid style.

The *Vedas*, the knowledge of which was unknown before, were the exclusive preserve of the Brahmans. They were written in verse form and consisted of commands and injunctions, hymns in praises and sacrifices to fire. There were different forms of recitation prevalent. Later they were divided into four groups. However, the vast majority of Brahmans did not understand them while only a few learned their explanation, and very few mastered its contents and interpretation. Not long before the time of al-Bīrūnī Vasukra of Kashmir on his own account undertook the task of explaining the *Vedas* and committing them to writing.⁴⁷²

Next came the *Puranas*, i.e., the first, eternal. They were eighteen in number and were composed by *rishis*. Out of the eighteen he had only seen portions of *Matsya*, *Aditva* and *Vayu Puranas*. He was the first Muslim to study the *Puranas*. Subsequent studies had shown that al-Bīrūnī's command over the *Puranas* and his quotations were quite accurate. Whatever differences there are could be due to the different recensions seen by al-Bīrūnī which are non-extant nowadays.⁴⁷³

The book *Smiriti*, derived from the *Veda*, contained commandments and prohibitions. Al-Bīrūnī enumerated twenty authors. He mentioned a number of other books including the book of *Patanjali* and *Vishnu Dharma*. At the same time he admitted the limitations of a foreigner to know all the books of the Hindus.⁴⁷⁴

He also referred to the *Mahabharat* of Vyasa, the son of

Parasara, which consisted of one hundred thousand verses, divided into eighteen books (*Parvan*) while the nineteenth, *Harivamsa-Parvan*, dealt with the tradition of Vasudeva.⁴⁷⁵ *Mahabharat* was regarded as the book of books comprehending all knowledge. However, it is difficult to know whether he had seen the *Ramayana*. He referred to it and was aware that Valmiki was a contemporary of Rama in *Treta-yuga* whose date could not be determined.⁴⁷⁶ He never referred to the early life of Rama and the monkey-god, Hanuman, but he knew the story about the relation of the monkey-*rāja* of Kihkind near Setubandha, the bridge of the ocean, two *farsakh* from Ramsher (Rameshar) who was revered and fed by the local people. He also knew that Rama was an *avatar* of Vishnu.⁴⁷⁷ Beyond that he was unable to learn about Kalidas and other great Indian literary figures.

Al-Bīrūnī's great quality was a correct realisation of his achievements and limitations. He admitted that he could not claim a thorough knowledge of grammar and meters but in order to acquaint his co-religionists with Hindu literature he proceeded to provide them with whatever information he commanded in this respect.⁴⁷⁸

It appears that besides his study of the *Vedas* and the *Puranas*, astronomy and astrology were the other fields of his extensive studies. Hindu standard books on astronomy were called *Siddhantas*, i.e., straight, not crooked or changing. There were five main *Siddhantas*. The other books which did not reach the standard of *Siddhantas* were called *Tantra*, ruling under a governor or Karna, i.e., following behind the *Siddhantas*. Among the astrological literature were the seven *Samhitas* meaning that which is collected, and included meteorology and cosmology. He also mentioned five *Jatakas* or books of nativities. In medicine they had the book of *Charaka*, the best of its kind. Besides these, there were a number of other sciences and books such as *Kalila wa Dimna*.⁴⁷⁹

It is but natural that as a historian and student of comparative religion, al-Bīrūnī should have evinced interest in ancient religions. As a true believer in Islam, he was not afraid to learn about them and was opposed to any prohibition against religious discussion for he knew that with a firm belief in Islam there was no fear of

one being swayed or influenced by other creeds. He was clear on this point and as Islam was truth itself it could not be compared with other false or corrupted forms of earlier religions.⁴⁸⁰ They could be compared with one another to facilitate understanding. His keen desire to learn about other religions urged him to be patient and persistent in efforts throughout his life to acquire the desired information. His efforts to trace the *Safar al-Isrār*, a book of Mānī, on which Zakriyya Razi's *Ilāhiyāt* was based, were crowned with success after forty years. The vast historical and other allied knowledge commanded by him and his linguistic facility placed him in a unique position to carry on the efforts of earlier writers such as Abū Ma'shar Balkhī, a step forward. His *Chronology* provided information about different religions and creeds found in the regions of the Caliphate while in *India* on the Initiative of Abū Sahl Tiflīsī he tried to provide a better book than his earlier translations of *Samkhya* and *Pātanjali* as a help to those who want to discuss religious questions with them.⁴⁸¹ Therefore, al-Bīrūnī never compared Islamic tenets with those of other religions as a true believer. The fact was that Islam was a great revolutionary religion, quite different from the others, while a comparison can be made in similarities. Nevertheless, al-Bīrūnī often referred to similar and parallel theories current among *sūfis* and found in other religions probably because he regarded such beliefs as heterodox and esoteric for he knew that efforts had been made to subvert the true teachings of Islam.⁴⁸² He, himself, was said to be a Zaidite in his earlier life but later appeared to have become a *tafdīlī* orthodox Sunni.⁴⁸³

In presenting this vast array of contemporary religious knowledge he followed the same principles of comparison, complete information, accuracy and unbiased treatment as he had shown in history. One would rather say that he enunciated these exacting standards for describing the beliefs and faith of ancient people and applied them to history as well. A glance over some of the topics discussed by the Khwārizmian sage would suffice:

Idolatry: Al-Bīrūnī explained the origin of this evil practice, in the form of idols or pictures in human weakness. The popular

world leans towards the sensible world, and has an aversion to the world of abstract thought which is only understood by the highly educated people. Therefore, many of the leaders of religious communities have so far deviated from the right path so as to reproduce the abstract through concrete imagery in their books and houses of worship, like the Jews and Christians, and more than all, the Manichaeans. He regarded these idols as monuments in honour of certain highly venerated persons, prophets, sages, angels, destined to keep alive their memory when they are absent or dead, to create for them a lasting place of grateful veneration in the hearts of men when they die.⁴⁸⁴

While discussing the origin of idolatry he mentioned its origin in the days of Serugh, the great grandfather of Abraham, while the Jews generally think Enoch as the originator. However, Serugh was also stated to have started idolatrous practices such as sooth-saying etc.⁴⁸⁵

Romulus and King Ambarisha were stated to have started the evil among the Romans and the Indians. He gave a detailed account of the famous idols of India and rules for making idols of *lingas* which were so common in the regions south-west of Sind. He also described the rules and conditions for their worship though he regarded this as a mad raving but mentioned it because it would enable one to identify an idol.⁴⁸⁶ He knew that educated Hindu priests used idolatry to keep the masses in thralldom. The Greeks also regarded them as intermediaries.

Scriptures: According to him confrontation with other religions led the Muslims to evolve a theory of Scriptures. They maintained that all revelations were made in the month of *Ramadan*.⁴⁸⁷ When al-Bīrūnī tried to find some correlation between the different dates and the month of *Ramadan* he found them irreconcilable. Therefore, he came to the conclusion that it was futile to search for a correlation or estimate the correct date. He also knew that there were a number of versions of Bible extant and that it was not a revealed book or a book of law. He was aware that a Greek *Torah* was current among the Christians but which was rejected by the Jews. He personally knew the *Old* and the *New Testament* and the four *Gospels*.

Cosmology: He was interested in cosmology.⁴⁸⁸ But he remained skeptical about the different cosmological theories of creation. He also found that different religions give different years as the age of the earth. The followers of Zartušt thought its age as 12,000 years, while the Buddhists ascribed it as one million years.⁴⁸⁹ He was also aware of the Iranian traditions about the first pair of human beings.

Demons and Spirit: He believed in *Jinns* on the evidence of the *Qur'ān* while the Greeks thought them to be beings of air and fire or remaining parts of erring soul. He mentioned the use of incense by the Khwārizmians to ward off evil spirits. He thought that incantations might be efficacious in warding off their evil effects.⁴⁹⁰

Qiblah: An interesting discussion was the different sides of *qiblah* current among different people. The Sabians and the Manichaeans turned towards the North Pole, the Harranians towards the South Pole while the Christians towards east.⁴⁹¹ He concurred with the observations of a Manichaean missionary that *qiblah* was merely a convenience.⁴⁹²

Burial Ceremonies: Earlier the practice was to expose the dead (in Iran). Subsequently they began to expose the dead to wind and as a result the Zoroastrian *dakharas* came into being. In India the origin of cremation popularly attributed to Narayana was practised, while the Greeks used both cremation and burial. The Buddhists threw their bodies in water.⁴⁹³ The Ghuzz Turks floated the body of a drowned man down the river.⁴⁹⁴

Different Sects: Al-Bīrūnī did not venture to put forward any general theory for the emergence of heresies and sects except in the case of Islam where according to him the Jews and the Manichaeans were responsible for subverting the true tenets of Islam.⁴⁹⁵ However, he was aware of the existing sects in contemporary non-Muslim societies. Among the Jews he mentioned the existence of the Rabbanites, Milodites, Qaraites, Maghidies and the Afaniyyas. They were still expecting the coming of the Messiah which gave birth to a number of false prophets. They believed that the anti-Christ would arise from the tribe of Benjamin.⁴⁹⁶

Besides them were the Samaritans who did not recognize any prophet after Moses. It is said that they had helped Nebuchadnezzar and did not celebrate the festival of the Tabernacle.⁴⁹⁷

The Christians were divided among the Melkites, Jacobites and Nestorians. The Melkites were found near Greece proper and also dispersed over Asian mainland upto Khwārizm and their *Catholicos* for the Arab countries resided at Baghdad. The Nestorians were found in Syria, Iraq and Khurasan, while the Jacobites were confined to Egypt. There were four main *patriarchs* situated at Constantinople, Rome, Alexandria and Antioch. Baghdad (and probably other Muslim areas) were controlled by Antioch but in fact were under the actual jurisdiction of the Caliph. He knew that dissensions among the Christians mainly centred the two natures of Christ and he found the explanation of Arrian nearer to the Muslim version. He also understood that the use of the term son for the Christ was used in a special sense. He was well-informed about the Church hierarchy. He acknowledged the idealistic tinge in Christian teachings but declared them to be impracticable for maintaining peace in society.⁴⁹⁸

The Sabians were another sect known to al-Bīrūnī masquerading as the people of the books referred in the Holy *Qur'ān*. It became a blanket word and provided cover to the pagan community of Harran who thus acquired the status of *Dhimmīs*. Al-Bīrūnī also described the Greek origin of their belief with their gods Agothodaimon, Hermes, Pythagoras, Walis Maba and Sawar. They worshipped heavenly bodies and followed the book of Hermes and turned towards the South Pole.

Among the non-revealed religions he described the Greek, Buddhist, Zoroastrian, Manichaeon and Hindu.

Al-Bīrūnī's information about the Greek religion was second hand. He knew, discussed and compared the Greek theories of the First Cause with other faiths. He knew about the five eternal things, the Creator, the Universal Soul, Primeval Matter, Space and Time.

They were idolatrous, anthropomorphical and believing in some form of metempsychosis.⁴⁹⁹

He had little information about Buddhism except the fact

that once it had spread upto the confines of Syria. He had misconceptions about the terms *Buddha*, *Dharma*, *Sangha*, particularly about *Sangha*. He described them as intelligence, religion and ignorance. His misinformation or lack of information was due to the disappearance of Buddhism from Iran, Afghanistan, Western Turkistan and Western India. Unable to read their scriptures he had to rely upon hearsay. Another curious reference about Buddha occurs as one of the gods of Hindu pantheon whose devotees were Shāminians, he was revered as the *avtar* of Vishnu, thereby indirectly showing the absorption of Buddhism by Vishnawism.⁵⁰⁰

Buddhism in the Iranian empire was replaced by Zoroastrianism aided by Gushtāsp. Al-Bīrūnī referred to an earlier form of Zoroastrianism no longer extant. He reported that the later Zoroastrians did not fast and recited their scriptures in a whispering tone, and that schism appeared within their ranks through the impact of Christianity.⁵⁰¹

A great syncretic movement which rent asunder the Zoroastrian society and was in turn highly persecuted was Manichaeism. Hard pressed they resorted to subtler methods of subversion and al-Bīrūnī's contemporaries thought that it was responsible for introducing the concepts of dualism in Islam.⁵⁰² Though Mānī tried to combine Zoroastrianism with Christianity he was closer to Christianity. It is said that he adopted the theory of transmigration of souls from Indian and claimed himself to be a prophet and the paraclete. His main tenets were dualism, the doctrine of Primeval Man and presence of soul in all matter. Most of the eastern Turks were reported to be Manichaeans.⁵⁰³

His study of *Samkhya*, *Gita*, *Patanjali*, *Vishu Dharma* and some of the *Puranas* together with this acquired information about the *Vedas* provided al-Bīrūnī with a unique opportunity to give the first objective description of Hindu beliefs. It may be conceded that he was representing Vishnawism and the Samkhya school, yet he wrote what he found in Western and Central India. He never referred to any Vendantic writer, nevertheless, his writings are full of references, Vendantic in nature.⁵⁰⁴

Like other developed societies in Hindu India, al-Bīrūnī found a dualism in beliefs i.e., the beliefs held by the educated (or scholars)

and the beliefs of the ignorant masses. This cleavage became wider with a dualism in linguistics. The language of the masses was quite different from that of the learned. Thus the educated disapproved of idolatry but the masses believed in it.⁵⁰⁵

The Hindu books of India such as *Samkhya* and *Gita* regarded God as one, eternal, omnipotent, beneficent, hidden to the senses. Opinions differed about Him and His action. Some regarded Him as the First Cause while the *Samkhya* school regarded action belonging to matter, and matter was bound by soul and caused it to wander in different shapes and conditions. Unity of God is absolute and everything besides it, a plurality. "It is not impossible to think that the existing beings are not and that He is, but it is impossible to think that He is not and that they are."⁵⁰⁶

Some of them went too far in their discussion. God is compared with a point to describe. His shapelessness and lack of space qualities. They began to think of God as a point.⁵⁰⁷

Hindus regarded all creation, a unity. Soul or *Purusha* were of two kinds, knowing and unknowing. From the latter proceeds action while knowing is the cause why an action ceased. Matter is moved by the three primeval forces, i.e., angelic, human and animal. As the soul wanted to know due to its non-development of intelligence, it has to move from different levels of existence. This migration or metempsychosis aimed at the disappearance of the shape of matter and acquiring of complete knowledge and allowing the soul to dispense away with the body.⁵⁰⁸

The worlds(*lokas*) were three. The upper, *Svarloka* or Paradise; the middle, *loka*, the world of men; the lower *loka* called *nāgaloka*. He enumerated hells and their categories. Some individuals thought that sinful souls had to go to hells for chastisement while according to others metempsychosis fulfils all such conditions and there is no need of hell.⁵⁰⁹

The Muslims of al-Bīrūnī's time knew that Hindus reconverted the apostate Hindus by using cow's excretion. The Hindus just denied this assertion.⁵¹⁰ However, rites of a similar nature were observed in the sub-continent when the *Shuddhi* movement was started.

While discussing all these religions al-Bīrūnī came to the

conclusion that each religion possesses certain distinctive characteristics not possessed by the others. Just as *Kalimah* is the basis of belief in Islam and its hallmark, Trinity among the Christians, Sabbath among the Jews and metempsychosis among Hindus hold the same position.⁵¹¹ Transmigration of soul, however, was common to Buddhism and the beliefs of *Mānī* as well. He had compared the different religions with one another and pointed out the common features such as the nature of the First Cause.⁵¹² Though averse to comparing Islam with other religions, however, when he found parallel views held by the *ṣūfīs* he promptly pointed them out.

Similarity of views held by the Greeks and the *ṣūfīs* led al-Bīrūnī to trace the origin of the word *ṣūfī* from the Greek language, where *ṣūfī* meant wisdom and, therefore, the philosopher was called *pailasopa*, i.e., loving wisdom. Those who adopted the doctrines of philosophers adopted their name as well. Misunderstanding led to its being confused with *ṣuffa*, as if the *ṣūfīs* were identical with *ahl-al-ṣuffa*. Subsequently people took it as a derivation from *ṣuf*, i.e., the wool of goats. Another opinion was that it was a corruption of *ṣāfī* meaning pure.⁵¹³

The views of the ancient Greeks and also of some Indian (Hindu) scholars that the First Cause has real existence, because it alone is self-sufficing, whilst everything else absolutely requires it; that a thing which for its existence stands in need of something else has only a dream life, no real life, and that reality is only that one and first being (the First Cause), was also held by the *ṣūfīs*.⁵¹⁴

Again the *ṣūfīs* and the Greeks held similar views about the relationship between the First Cause and the World. The existing world is only one thing; that the First Cause appears in it under various shapes; that the power of the First Cause is inherent in the parts of the world under different circumstances, which cause a certain difference of the things of the world notwithstanding their original unity.

Thus, like the Hindus and the Greek, the *ṣūfīs* taught that "this world is a sleeping soul and yonder world a soul awake", and that "God is immanent in certain places e.g., in heaven, in

the seat and the throne of God".⁵¹⁵

Like the *Samkhya*, the *ṣūfīs* did not consider the stay in Paradise, a special gain. However, the *Samkhya* disapproved because it was an end in itself, and because it resembled the life of this our world. The *ṣūfīs* disregarded it for another reason, because there the soul delights in other things but the Truth, and its thoughts are diverted from the Absolute Good by things which are not the Absolute Good.⁵¹⁶

The concept of metempsychosis also influenced Muslim thinking. According to a theosoph the metempsychosis had four degrees.

1. The transferring, i.e., the procreation, and limited to the human species, because it transfers existence from one individual to another; the opposite of this is the transforming.
2. The transforming which concerns men in particular since they are transformed into monkeys, pigs and elephants.
3. A stable condition of existence, like the condition of the plants. This is worse than transferring, because it is a stable condition of life, remains as it is through all time, and lasts as long as the mountains.
4. The dispersing, the opposite of No. 3, which applies to the plants that are plucked, and to animals immolated as sacrifice, because they vanish without leaving posterity.

According to another view the metempsychosis always proceeds in one and the same species, never crossing its limits and passing into another species.⁵¹⁷

While discussing the concept of *moksha* (salvation) al-Bīrūnī found a close parallel between the Hindu, Christian and *ṣūfī* thinking. The Hindus regarded the bond which bound the soul to this world as ignorance, and therefore its opposite, knowledge could help it in gaining liberation. When the individual reached this stage, he came into the possession of miraculous powers.

The terms of the *ṣūfī* as to the knowing being and his attaining the stage of knowledge came to the same effect, for they maintain that he has two souls, an eternal one, not exposed to change and

alternation, by which he knows that which is hidden, the transcendental world, and performs wonder; and another, a human soul, which is liable to being changed and being born.

To the Greeks, such as Socrates and to the *ṣūfīs* this liberation was in the form of love for the First Cause. These *ṣūfīs* defined *love* being engrossed by the creature to the exclusion of God.

The Hindu sages held the view that a liberated soul dispenses away with body, the worldly fetter. Al-Bīrūnī recited a similar story popular among the *ṣūfīs* and related by one of their authors: A company of *ṣūfīs* came down to us, and sat down at some distance from us. Then one of them rose, prayed, and on having finished his prayer, turned towards me and spoke: Master, do you know here a place fit for us to die on? Now I thought he meant sleeping and so I pointed out to him a place. The man went there threw himself on the back of his head, and remained motionless. Now I rose, went to him and shook him, but lo! he was already cold.

The *ṣūfī* explains the Koranic (Qur'ānic) verse, 'We have made room for him on earth' (*Sura*, 18-83) in this way: If he wishes, the earth rolls itself up for him; if he wishes, he can walk on the water and in the air, which offer him sufficient resistance so as to enable him to walk, whilst the mountains do not offer him any resistance when he wants to pass through them. ⁵¹⁸

From *moksha*, al-Bīrūnī went to discussing various ways of attaining it and the union of *Brahman* with the liberated soul. This doctrine succinctly explained by Arjuna in *Patanjali* by an illustration was akin to that of the *ṣūfī* regarding being occupied in meditation on the truth (i.e. God) for they say, "As long as you point to something, you are not a monist; but when the Truth seizes upon the object of your pointing and annihilates it, then there is no longer an indicating person nor an object indicated." ⁵¹⁹

There are some passages in their system which show that they believe in the pantheistic union (*Wahdat al-Wujūd*) e.g., one of them, being asked what is the Truth (God), gave the following answer: "How should I not know the being which is I in essence and not I in space? If I return once more in existence, thereby I am separated from him; and if I am neglected (i.e., not born anew and sent into the world), thereby I become light and become accustomed

to the union" (*sic*).⁵²⁰

'Abū Bakr al-Shiblī says: "Cast off all, and you will attain to us completely. Then you will exist: but you will not report about us to others as long as your doing is like ours."

'Abū Yazīd al-Bistāmī once being asked how he had attained his stage in *sūfism*, answered: "I cast off my own self as a serpent casts off its skin. Then I considered my own self, and found that I was He, i.e. God."

The *sūfīs* explain the Qur'ānic passage (*Sūrah* 2, 68), "Then We spoke: Beat him with a part of her", in the following manner: The order to kill that which is dead in order to give life to it indicates that the heart does not become alive by the lights of knowledge unless the body be killed by ascetic practice to such a degree that it does not any more exist as a reality, but only in a formal way, whilst your heart is a reality on which no object of the formal world has any influence.

Further they say: Between man and God there are a thousand stages of light and darkness. Men exert themselves to pass through darkness. To light, there is no return for them.

These references showing the attitude and information of a non-*sūfī* scholar, also throw light on al-Bīrūnī's comprehensive knowledge. His comparative study of *sūfism* with the Greek and Indian philosophies point to these exotic influences in *sūfī* thought. The influence of the book of *Patanjali* and of the Samkhya school on *sūfī* thought would form an interesting study.⁵²¹

REFERENCES

CHAPTER I

1. See Suniti Kumar Chatterjee, *Al-Biruni and Sanskrit, Al-Biruni Commemorative Volume*, 1951, Calcutta, p. 100.
2. See Arnold Toynbee, *A Study of History*, abridged ed., Somerwell, p. 18.
3. See *A Study of History*, p. 17. Also see the same author's *Growth of Civilizations*, pp. 749-50; also the Tables on cultural epochs in Oswald Spengler's *Decline of the West*.
4. See *Growth of Civilizations*, p. 389.
5. See Bertold Spuler, *The Persian Heritage*, and Grunebaum's *Unity and Variety in the Muslim Civilization*, p. 167, cf. Hitti, *The Near East in History*, pp. 212-13.
6. Jacques Pirene, *The Tides of History*, Vol. 1, p. 31.
7. It is rather surprising that this view also recurs with modifications among modern writers. Among the modern philosophers of history, Spengler, in particular, advises the relinquishment of the lyrical in favour of engineering and ship-building, fossilization of culture (civilization) in favour of empire-building and so on.
8. See Hitti, *op. cit.*, pp. 187-88.
9. See Toynbee, *Growth of Civilizations*, pp. 424-25.
10. See Hitti, *op. cit.*, pp. 187-88.
11. Records of the wars do not support this contention. The Persians fought savagely and bitterly. The battle of Qadsiyah which decided the fate of Iraq was fought for 7 days.
12. The people of Hims though professing Christian faith were so charmed by the first Arab rule that they prayed for Muslim victory.
13. The Embassy of the Byzantine governor of high and lofty Egypt regarded the Muslims as invincible because of their morals, piety and sense of

equality. This report made the governor come to terms with the Muslims. Similarly when the Muslims crossed River Euphrates the Persians were overawed and thinking the Muslims as superhuman beings, fled in terror.

14. It is said that Hellenistic influence was superficial. See A.J. Arberry, the *Legacy of Persia*, Oxford, 1953, p. 21 cf. Noedeka as quoted in Browne, *A Literary History of Persia*, Vol. II, p. 4. It would also be seen that a schism had gone deep into Persia with regard to religion. The schismatic school led by Mānī (predicating the battle between good and evil through light and darkness) and his subsequent murder are pointers to the decline of the Sassanian Iran.
15. Lane Poole, *Mohammadan Dynasties*, p. 6. Also see Abu-al'Ala'Maududi's *Khilafat wa Malukkiyat*, pp. 155–204.
16. See Grunebaum, *Unity and Variety in the Muslim Civilization*, 1955, Chicago, introduction.
17. They were designated as *Sha'ūbiyyah*, meaning partisan or Gentiles. See Browne, Vol. I, p. 265.
18. See O'Leary, *Arabic Thought and its Place in History*, p. 89; Browne, *The Literary History of Persia*, Vol. II, p. 222.
19. Al-Tabarī, Vol. VI, pp. 82–83; Ibn al-Athīr, Vol. IV, p. 325; Al-Bidayah, Vol. X, p. 41.
20. Mas'ūdī, *Muruj al-Dhahab*, Vol. II, p. 69.
21. The Jabal of Khurasan continued to be a strong centre of Khurramī doctrines and Bābak Khurramī in the reign of Ma'mūn declared himself to be a prophet and continued to rule independently for twenty years (200–221 A.H.).
22. When Sanbād revolted after the death of Abū Muslim, another companion of Abū Muslim fled to Turkistan.
23. The Rāwandīs came to the 'Abbasid capital and began to circumambulate Caliph Mansūr's palace shouting that he was their *rab* (god). Mansūr crushed them severely.
24. Sanbād, one of the chief supporters of Abū Muslim was a *majūsī*. See Browne, *op. cit.* Vol. I, pp. 279–93.
25. See Arnold, T.W., *The Caliphate*, p. 27.
26. A brief sketch showing the various eastern kingdoms is as follows: 9th and 10th centuries: 820–872 A.D. Khurasan: The Tāhirids. See *Mohammadan Dynasties*, p. 128. 825–898 A.D. Kurdistan: The Dulafids p. 125. 864–928 A.D. Tabaristān: The 'Alids p. 127. 867–903 A.D. Sīstān and the Saffārids p. 129. 874–899 A.D. Transoxiana: The Sāmānids p. 131. 879–930 A.D. Adharbijan: The Sājids p. 126. 10th and 11th centuries: 928–1042 A.D. Jurjān: The Ziyārids p. 136. 932–1055 A.D. South Persia and Iraq: The Buwayhids p. 139. 932–1165 A.D. Turkistan: The

Ilak Khans p. 134. 959–1015 A.D. Kurdistan: The Husanwayhids p. 138. 962–1186 A.D. Transoxiana: The Ghaznawids p. 285, Persia and Pakistan. Bābak revolted against Ma'mūn and ruled independently for twenty years (816–38 A.D.). He was defeated by Afshīn, a Turkish chief converted to Islam. His success shows the strength of the Muzdakite and Khurramī beliefs in the mountainous regions of Khurasan. Afshīn was ambitious and he wanted to capture Khurasan. It is said that he incited Māzyār, the prince of Tabāristān to revolt, in the belief that he would be asked to crush it. Thus securing his position as a great general he would be able to oust 'Abd Allāh, the Tāhirid from Khurasan. But 'Abd Allāh, himself a noted general and administrator, defeated Māzyār and informed Mu'tasim, the Caliph, who had Afshīn imprisoned and killed. It is suggested that Bābak, Afshīn and Māzyār represented the nationalistic aspirations of the Persians. See Browne, Vol. I, p. 336; *Mohammadan Dynasties*, p. 128.

27. *Mohammadan Dynasties*, p. 128; *Rawdat al-Safā*, Vol. VI, p. 10. Though the Saffarids had been generally regarded as Persian in origin, and tradition associates them with earliest patronage of the Persian language, nevertheless another opinion is that they were in fact Arab in origin and were fighting against the rising tide of non-Arab dynasties. See Mu'in Nadwi, *Tarikh-i-Islam*, Vol. III, p. 277 et seq.
28. Ibn al-Athīr, Vol IX, p. 55. See also *Mohammadan Dynasties*, p. 131. *Rawdat al-Safā*, Vol. IV, pp. 10–24.
29. Girdizi, *Zayn al-Akhbar*, Persian, 1327, Tehran, pp. 13–49. See also *Mohammadan Dynasties*, p. 139.
30. He burnt the idols of Samarqand destroying people's faith in their divinity. He also offered two dirhams for offering Jum'ah prayers. The Qur'ān was also translated into Persian during his reign.
31. It is said that, at this period, a mission was led by one, 'Khawājah Sāhib' to China where the Sung dynasty was in power. He may be identified with Khawājah Abū Nasr who as a merchant and missionary could have been chosen by Sātuq Bughrā to promote friendly relations in order to forestall any Chinese interference in his drive for unification of the Turkish tribes.
32. See *Mohammadan Dynasties*, p. 134.
33. An erroneous impression was created by Raverty's mistake in confusing these Khāns with the Ilak Khān of Kashghar who was presumed as non-Muslim. This confusion led Raverty and subsequently Arnold to assume that the regions of Eastern Turkistan were still non-Muslim. But the Ilak Khāns were already Muslims and Mahmūd married one of the daughters of Ilak Khan. See Nazim, *Life and Times of Mahmūd of Ghazna*, pp. 47–56, cf. Barthold, pp. 228–86, and J.R.A.S., 1898, pp. 467–

502. See Arnold, *Preaching of Islam*, 1913, London, pp. 214–216.

34. See for the impact of Tarāz or Talās; Badr al-Din Chīnī, *Chin Wa Arab Ta'alluqāt*, 1949, Karachi, pp. 50–51. See also Barthold, *Turkistan Down to the Mongol Invasion*, p. 196.
35. Tughān Khān collected *sad hazār* (one thousand) troops to check the Chinese. See *Tārīkh-i-Yemenī* (Persian), p. 233.
36. Al-Bīrūnī, *The Chronology*, Arabic Text, p. 36; *The Encyclopaedia of Islam*. See under *Khwarizm* and *Khwarizm Shāh*. Kāth was one of the two capital cities of the region of *Khwarizm*. It was situated on the eastern side of the Oxus towards Turkistau. The town still exists. However, it has passed through fluctuating fortunes. It seems that after the 10th century it lost its importance and was replaced by its rival Jurjāniyah which later came to be referred to under the name of *Khwarizm* city. Finally Khiva became the capital of the region. Kāth still exists some miles away from the site of the ruins of the old city. See le Strange, *The Lands of the Eastern Caliphate*, Cambridge, 1930, pp. 446–47. See also Ya'qut, *Mu'jam al-Buldān*, Egypt, Vol. III, pp. 474–78. Kāth bears a close resemblance with a number of names of other sites and regions such as Kash-mir, Kash-mor, etc.
37. Al-Bīrūnī has referred to it in *Canon Masudicus* both as Gargānj and Jurjāniya. According to Ya'qūt Garganj was its local name and Jurjāniya its Arabicized form. It was twenty *farsakh* from Kāth. Some scholars suggested that Ma'mūn b. Muḥammad was a descendent of Farīghūn while the rulers of Jurjānan were called Farīgh-unids. Out of them Abu'al-Ḥārith was the father-in-law of Maḥmūd and supported him against his younger brother Ismā'īl (see *Tārīkh-i-Yemenī*), Persian Tr. pp. 63, 84 and 124). See Farhang-i-Nasrī as quoted by Browne, Vol. II, pp. 237, no. 3. See also 'Utbi, Vol. II, pp. 101–105, Cairo ed. cf. Nazim, *The Life and Times of Sultan Maḥmūd of Ghazna*, pp. 39–40; appendices, cf. Barthold, *Turkistan Down to the Mongol Invasion*.
38. 'Utbi, p. 80; Gardizi, p. 55; Yemeni, pp. 47–99; Gardizi, Persian, pp. 20–49, Yemeni pp. 86–89. See also *Mohammadan Dynasties*, p. 134.
39. Nasā was a city of Khurāsān situated at five days journey from Merv.
40. Abīward, another city of Khurāsān situated between Nasā and Sarakhs.
41. See *Mohammadan Dynasties*, p. 286. Gardezi, Persian, p. 57; Yemeni, Persian, p. 240.
42. Various accounts of Maḥmūd's conflict with *Khwarizm*'s Ma'mūnids have been given by the chronicles which will be discussed at an appropriate place. The above account given by Bayhaqi from al-Bīrūnī's history of *Khwarizm* entitled *Masāmīr-i-Khwarizm* (not extant) is to be accepted as the most authentic for al-Bīrūnī himself was an

- actor in the whole tragedy. See Bayhaqi, pp. 838–39; 'Utbi, Persian, p. 240; *Rawḍat al-Safā*, Vol. 6, pp. 30–40.
43. Bayhaqi, p. 846; *ibid*, p. 816.
 44. 'Utbi, pp. 240–1 and 6. Bayhaqi, p. 844.
 45. Māh̄mūd came with his army to Tirmidh and embarked it on boats. Bayhaqi, pp. 849–51, *Rawḍat al-Safā*, p. 40; Rashīd al-Dīn, *Jamī 'al-Tawārīkh*, p. 150; Firishṭah, *Gulshan-i-Ibrahīmī*, Vol. I, p. 49.
 46. Tarikh-i-Yemeni, Persian, pp. 31–49; *Rawḍat al-Safā*, Vol. VI, pp. 30–39. See Nāzim, pp. 25–26.
 47. The first clash occurred when Alaptgīn occupied Bust and some portions of Hindūshāhī dominions (963 A.D.). The second clash came when Abū 'Alī Lawīk, son of the former ruler of Ghaznah, tried to retake his patrimony with the help of the son of the King of Kabul. Both of whom were captured and killed by Subuktgīn, the commander of the Ghaznah army (977 A.D.). The clash developed into a serious conflict in the reign of Subuktgīn who occupied regions upto Peshawar. *Tabaqāt-i-Nasrī*; Qandhar ed., Vol. I, pp. 270–71, Firishṭah, Vol. I, pp. 38–45.
 48. Such an earlier empire was established by the Kushans. See Arnold J. Toynbee, *Between Oxus and Jumna*, p. 5.
 49. See Bertold, *Mussalman Culture*, Eng. Tr. p. 7. The agriculturists and the merchants in Iran became one caste (*ibid*, p. 7). This is what had already happened in India where the Vaishya came to comprise all the non-Brahmans and non-Kshatriyas, tended to become closer to the Shudras in the face of the domination of the upper castes among whom the Brahman began to claim themselves to be superior to all.
 50. Abu Sahl Masiḥī completed his studies in Baghdad. He was a member of the Ma'mūnid Court of Khwarizm.
 51. *Rawḍat al-Safā*, Vol. 6, p. 3.
 52. Iṣṭakhri, *Kitāb al-Aqālīm*, p. 261.
 53. Qazwini, *Āthār al-Bilād*, p. 374.
 54. Idrīsi, *Nuzhat al-Mushtāq*, p. 259.
 55. See Barthold, *Turkistan Down to the Mongol Invasion*, p. 236.
 56. *Nuzhat al-Mushtāq*, Vol. II, p. 297.
 57. See Bertold, *Mussalman Culture*, p. 8.
 58. See Barthold, *Turkistan Down to the Mongol Invasion*, pp. 235–36.
 59. An idea of the huge amount of wealth which was remitted from the eastern parts of the Caliphate may be formed from the following list compiled by Ibn Khaldūn and Jahshiyahānī (vide Ḥussain, S.A.Q., *Arab Administration*, pp. 199–203).

| Province | Revenue realized in terms of Goods | Dirhams |
|--|---|------------|
| 1. Hulwan | — | 4,800,000 |
| 2. Al-Ahwaz | Sugar, 30,000 <i>ratls</i> . | 25,000,000 |
| 3. Fars | Black raisins, 200,000 <i>ratls</i> , pomegranates and quinces 250,000 in number, rose-water 30,000 bottles, mangoes 15,000 <i>ratls</i> , sirafi clay (edible) 50,000 <i>ratls</i> , raisins three Hashmi Kurrs. | |
| 4. Kirman | — | 4,200,000 |
| 5. Makran | — | 4,000,000 |
| 6. Sind and the adjoining area | Elephants (Nos. 3), hashishi robes 2000 pieces, waist wrappers 4,000 nos., Indian incense 150 <i>ratls</i> , other kinds of aloe-wood 150 maunds, sandals 2,000 pairs, cloves and nutmegs also. | |
| 7. Sijistān (Sīstān) | Stipulated clothes 300 pieces, al-fard (sweets) 20,000 <i>ratls</i> . | 4,000,000 |
| 8. Khurasan | Pure silver ingots No. 2,000, pack horses 4,000, slaves 1,000, cloth pieces 27,000, myrobalan 300 <i>ratls</i> . | |
| 9. Jurjān | Silk 61,000 pieces. | 12,000,000 |
| 10. Qumis | Pure silver ingots 1,000, garments 70 pieces, pomegranates 40,000. | 1,500,000 |
| 11. Tabāristān, Rugom and Dunbawand | Tabārī carpets 600 pieces, cloth 300 pieces, kerchiefs, 300 pieces, vessels (al-jar) 600. | 6,300,000 |
| 12. Rayy | Pomegranates 10,000,000, peaches 1,000 <i>ratls</i> , honey 20,000 <i>ratls</i> . | 12,000,000 |
| 13. Isfahan (excluding Khatmesh and rural areas of Isa Radis | Honey 20,000 <i>ratls</i> , wax 20,000 <i>ratls</i> . | 11,000,000 |
| 14. Hamadan Dastaba | Plums 1,000 <i>ratls</i> , and robes honey of Arwand 20,000 <i>ratls</i> . | 11,800,000 |

N.B. It should be noted that the total cash revenue including the goods received in kind amounted to 163,200,000 dirhams while the total receipts of the 'Abbasid Caliphate after meeting the provincial expenses amounted to 400 to 500 million dirhams. The income of the three richest provinces of the Caliphate was as follows:

| | dirhams |
|---|------------|
| 1. Al-Sawād | 95,580,000 |
| 2. Egypt (excluding Tunis, Dimyat and Al-Ashnūn). | 46,080,000 |
| 3. Khurasan | 28,000,000 |

See al-Jahshiyānī, p. 364; Ḥussāin, *op. cit.*, p. 199.

60. These revolts were by (i) Sanbād the Magian (754–55 A.D.); (ii) Ustādhīs (766–68 A.D.); (iii) Yūsuf al-Baran and al-Muqannah (777–80 A.D.), and (iv) 'Alī Mazdak (833 A.D.). See Browne, Vol. I. pp. 246. Bertold, *Mussalman Culture*, pp. 72–74; Hollister, *Shi'a in India*, pp. 311–15.
61. See Ibn-i Athīr, Vol. V, p. 194. See also Ansar Zahid Khan's thesis, *Sind under the Mughuls*, Chapter on Religion.
62. Yemeni, p. 180.
63. Yemeni, pp. 237–239.
64. See Browne, *op. cit.*, Vol. I, pp. 291–93.
65. The Qur'ān, Eng. tr. Marmaduke Pickthall, Surah XCVI.
66. He asked the Muslims to travel even to China to learn. He also designated the ulema as his successors.
67. In the Pahlavi the twenty-two consonants of the parent Aramaic alphabets were reduced to fourteen only. See Arberry, *The Legacy of Persia*, Oxford, 1953, pp. 105–191.
68. See introduction to *Qanūn al-Mas'ūdi*, Tr. Barani in al-Biruni, Ur. pp. 228–29.
69. See Hitti, *The Middle East in History*, p. 247.
70. See Stanley Lane Poole, *The Moors in Spain*, London, 1888, p. 155.
71. Ma'mūn requested the contemporary Byzantine emperor for the original texts for translation. See *Akhbār al-Hukamā*, p. 23.
72. *Chahār Maqālah*, pp. 27–28.
73. The Caliph sent an epistle bearing three alphabets only. These alphabets refer to the episode of Abrahā Ashram's attack on Mecca. The Caliph meant that as Mecca was saved by God from the elephants of Abrahā so Baghdad and the Caliph would be saved from Maḥmūd's elephants. Incidentally the officer-in-charge of Abrahā's elephants corps was called Maḥmūd. The episode reflects the concept of the sanctity of the Caliphate. Maḥmūd as a staunch Muslim repented his audacity. See Firīštah, Vol. I, p. 8.

74. See Browne, *op.cit.*, Vol. II, pp. 45—46; O'Leary, *Arabic Thought in History*, p. 172.
75. Nicholson, *A Literary History of the Arabs*, Cambridge, 1953, p. 418, Maqqari, Vol. II, p. 83. See Lane Poole, *Moors in Spain*, pp. 81—82.
76. See al-Bīrūnī, *India*, Eng. Tr. Vol. I, p. 152.
77. Arberry, *Aspects of Islamic Civilization*, p. 138.
78. Al-Tawhīdī, *Muqahasiṭ*.
79. S. Hossein Nasr, *Science and Civilization in Islam*, p. 44. See also Afnan, *Avicenna*, p. 20.
80. Ibn al-Haytham, *Al-Manāzīr*, vide *Shahhat*, Abu al-Rayhān al-Bīrūnī, p. 49.
81. See *Shahhat*, *op.cit.*, p. 49.
82. See al-Ghazali. *Mi'yar al-'ilm fi Fanūn*.
83. See al-Bīrūnī, *India*, Eng. Tr. Sachau, Vol. I, p. 7.
84. See Hossein Nasr, *op. cit.*, pp. 30—32; Badr al-Din Chini, *Chin wa Arab Key Ta'alluqāt*, Karachi, 1949, Chapters II and VII.
85. A subject-wise list of some of the scholars will show the diversity of talent and interest. *Fiqh*: Al-Qudūri, Ibn al-Suraijja, and Ibrāhīm al-Marwazi. *History*: Ibn Zulaq, Al-Mustājī, Al-Shahshī and Al-Ṭabari. *Geography and Travels*: Ibn Hawqal and al-Mas'ūdī Iṣṭakhri. *Literature*: Abu Hilal Al-Sahi, Al-Barmaki, Badī' al Zaman Al-Hamdānī, 'Alī 'Aziz al-Jurjānī. *Sciences*: Al-Fārabi, Ibn Sīnā, Ibn al-Haytham. *Mathematics*: Al-Bīrūnī, Al-Būzjānī, Al-Baṭṭāni. *Physics*: Al-Khwārizmi, Al-Khazin. *Astronomy*: Al-Qurayshi, 'Umar al-Khayyam. *Medicine, Philosophy and Scholastic Philosophy*: Al-Kindī, Al-Fārabi, Ibn Sīnā, Al-Kalbī, Al-Balkhi, Al-Ḥassan Al-Ash'arī. *Calligraphy*: Ibn Muqlah. *Rhetorics*: Ibn Nubatah.
86. See Sarton, *op. cit.*, Vol. I, pp. 693—737.
87. Some of these scholars were as follows: *Traditions and linguistics*: Al-Naishāpuri, Al-Darqutmi, Abu 'Alī al-Fārisī, Ibn Duraid, Al-Nahhas. *Grammar*: Ibn Faris, Ibn Juyūnī, Al-Zajjāj and Ibn Durusawāih. *Poetry*: Al-Mutanabbi, Ibn Ḥajjāj, Ibn-Sakarah, Ibn Ṭabataba, Abu Firas.
88. *Lubub al-Lubab*, pp. 1—27.
89. See also Ma'sūm, *Tarikh-i-Ma'sūmi*, Bombay, 1938, pp. 32. *The Legacy of Persia*, p. 178.
90. See *Kitab al-Saydanah*, vide Afnan, *op. cit.*, p. 52. See also Browne, Vol. II, p. 7.

CHAPTER II

91. In this letter Abū Rayhān sent a list of his books as well as those of Rāzī (Rhazes).

- It is included in the *Risālah al-Fihrist*. Later its commentary entitled *al-Mushatah* was written by Abu Ishāq Ibrāhīm b. Muḥammad al-Ghāḍanfar al-Tabṣīrī (1232–92 A.D.). See the *Chronology*, Arabic text, Sachau, p. 15. Boilot. Beruni, the *Encyclopaedia of Islam*, p. 1236, Sachau, *Introduction to India*, p. VIII; Suleman Nadwi, *Al-Biruni's life, the Commemorative Volume*, p. 251; Ziya Barni, *Al-Birūnī* Ur. p. 29.
92. Ya'qūt, *Mu'jam al-Ubādā*, Cairo, Vol. XVIII, p. 180.
 93. In Iran and in the sub-continent terms as *birūnī-Shahr*, *birūnī-i-qilah*, *bālā-i-qila'ah* are still in vogue.
 94. See Elliot, *History of India*, Vol. I, pp. 396–40; Hodiwalla, *Studies in Indo-Muslim History*, Bombay, 1939, p. 75.
 95. See for details and excerpts from this *risālah* and its *Sharh al-Mushatah al-risālat al-Fihrist* as quoted by Sachau in the *Chronology*. See also Ya'qūt *Mu'jam al-Ubādā*, Vol. XVIII, p. 180.
 96. See Sachau, the *Chronology*, pp. XII–XVI; Ya'qūt, *Mu'jam al-Ubādā*, Vol. XVIII, p. 180; also see Ḥājī Khalifa, *Kashf al-Zunun*, Vol. II, pp. 430, 1065, 1314 & 1085. Nadwi, *Com. Vol.*, p. 252; *Encl. of Islam*, p. 1236.
 97. It seems that the poet wanted to belittle al-Birūnī for Umm Jamil, wife of Abu Jahal (designated as *Hamma lat al-Hatab* by the Qur'ān), was condemned by the Qur'ān for her enmity towards the Prophet. She used to spread thorns in his way. Family affiliations with Abu Lahab, a senior chief among the Quraysh, were never regarded as degrading in themselves. However, references to Abū Lahab or Abu Jahal etc., were, and are, generally used to show dislike and disapproval. Therefore, the reference does not mean that the parents of Abu Rayhan, were non-Muslims and died as non-Muslims like Abu Lahab. See Ibn Ishaq, *The Life of Muḥammad*, Eng. Tr., A. Guillaume, Oxford Press, 1967, p. 161. Abu Lahab also threw rubbish in his way. See Ibn Sa'ad, *Kitāb al-Tabaqāt al-Kabīr*, Eng. Tr., Moinul Haq, Karachi, 1967, Vol. I, p. 232.
 98. Ya'qūt, *Mu'jam al-Udaba*, Vol. XVIII, p. 189. See *Chronology*, p. 184. The terms *ustādḥ* could have been used in a reverential manner as well.
 99. Ya'qūt, Vol. XVII, p. 187.
 100. Ya'qūt, *op. cit.*, Vol. XVIII, p. 186.
 101. Ya'qūt, *op. cit.*, Vol. XVIII, p. 186. (See Arberry, *Life of a Philosopher, Aspects of Islamic Civilization*, London, 1964, pp. 136–37). Later chronicles vehemently castigate him for his Ismā'īlī beliefs. See Bayhaqī's, *Tatimmat Siwan al-Hikma*, p. 40. Vide Afnan, *Avicenna*, London, 1958, p. 58.

102. See the *Chronology*, p. 25. See also Suleman Nadwi, *al-Bīrūnī, Com. Vol.*, p. 257.
103. See Sarton, *Introduction to the History of Science*, Baltimore, 1950, Vol. I, pp. 563–64.
104. See the *Chronology*, under the months and festivals of Khwārizm. Abu Saʿīd Ahmad b. Muḥammad b. ʿIrāq was credited with the reform of the Khwārizmian calendar by al-Bīrūnī.
105. Naṣīr al-Dīn Ṭūsī says that according to al-Bīrūnī the credit for this discovery goes to Abu Naṣr Maṣṣūr. See Ṭūsī, *Kitāb al-Shakl al-qataʿ*, Istanbul, 1309 A.H., p. 108. See also Sarton, *op. cit.*, pp. 667–668.
106. Ibn Sīnā appears to have acquired all his knowledge at Bukhara. By the time he reached his eighteenth year he had exhausted all these sciences. In his own words, "My memory for learning was at that period of my life better than it is now, but today I am more mature; apart from this my knowledge is exactly the same ..." See Arberry, *Aspects of Islamic Civilization*, p. 189.
107. See Sachau, *India*, Vol. I, p. XVI.
108. 'A translation of his (Pulisa) whole work into Arabic has not hitherto been undertaken because in his mathematical problems there is an evidence of religious and theological tendency.' Al-Bīrūnī, *India*, Vol. I, p. 375.
109. A comparison of the Greek texts quoted in al-Bīrūnī's books with the original Greek shows that they were from good but free translation of Hunayn b. Ishāq or Yahyā b. Adi. See Gabraīlī, *Le Citazioni Delle Leqqi in al-Biruni, Com. Vol.*, pp. 107–10.
110. See the introduction of the *Kitāb al-Saydanah*, Hamdard National Foundation, Pakistan; Eng. Tr. by F. Krencow, Biruni and the Ms. *Sulṭān Fāṭih*, No. 3386, *Com. Vol.* p. 195.
111. He acquired a copy of *Chahār Nāmah* in Syriac, (*Ibid.*, pp. 195–96).
112. Some of the Greek authors and books studied by al-Bīrūnī were Plato, *Phaedo*, *Timaeus* (it included an appendix relating to the pedigree of Hippocrates). Proclus, commentary on *Timaeus* (different from the extant one).
113. See *infra*, Chapter IV.
114. *Qānūn al-Masʿūdī*, Book III, Chapter VIII.
115. *India*, Vol. I, pp. 23–24 and 178–79. An idea of the extent of his command over Sanskrit may be had by a perusal of the list of 25 Indian terms of astronomy and their equivalents in Arabic.
116. *India*, Vol. I, pp. 23–24.
117. Chatterji, *al-Biruni and Sanskrit, Com. Vol.*, p. 86.
118. *Ibid.*, *Com. Vol.*, p. 89.

119. *Ibid*, *Com. Vol.*, p. 90.
120. *Ibid.*, pp. 90–92.
121. See Jogonda, Remarks on al-Biruni's Quotations from Sanskrit Texts, *Com. Vol.*, p. 118.
122. See *India*, Chapter II. Also see H. Heras: The Advaita Doctrone in Al-Bīrūnī, *Com. Vol.*, p. 119.
123. (A): 1. *India*, Vol. I, p. 31. 2. Gavaka tr. 'Alī Ibn Zayn. 3. *Panchtantra* (*Kalila and Dimna*) (fiction). See *India*, Ch. II. 4. *Vittis vara karnasara* (*India*, II, 55). 5. Astronomy, physics, *Ghurāt al-Zijāt*, (*Karanatilaka*) by Abu Muḥammad al-Nā'ib from Amul.

(B) Studies in India: Theology and Philosophy: Kapile: *Samkhya*, *Book of Patanjali*, *Gita* (*Bhagvadgita*), *Puranic Literature: Vishnu-Dharma*, *Vishnu-purana*, *Matsya-purana*, *Vaya-purana*, *Aditya-purana*.

- (C) Al-Bīrūnī's Study of Indian Books, Astronomy, Astrology, Chronology and Geography: 1. *Brahmagupta: Pulisa Siddhanta: Brahma Siddhanta, khandakhadyaka, Utarakhand khadyaka*. 2. Balabhadra, Commentary of the *khandakhadyaka* and some other works. 3. *Varahamihira: Commentary of the Brihatsamhita*. 4. *Utpala of Kashmir: The Srudha (Sarvadhara)*. 5. *Aryabhata Junior, a book*. 6. *Vittesvara; karnasara*. 7. *Vijyanandin: karnaatilaka*. 8. *Pūnala: The Minor Manasa*. 9. *Mahadev: Srudheva (Saravodharm)*. 10. *Sripala: Candrabija*. 10. *Book of the Rishis*. 11. *Book of the Brahman: Bhattila*. 12. *Book of Durlabha* from Multan. 13. *Book jiuasarman*. 14. *Book of Samaya*. 15. *Book of Auliatha* (the son of Sahawi?). 16. *Calendar from Kashmir*. 17. *Lexicography: Haribhata*. 18. A book on the Medicine of Elephants. Books referred but probably not studied: *Mahabharata*, *Ramayana*, and *Manu's Dharmasastra*. Some of his informants were mere individuals as those from Somnath, (*India*, Vol. I, pp. 161, 165), from Qannawj (*ibid.*, Vol. I, 165, Vol. II, p. 129).
124. See *India*, Chapter II.
 125. By his writings and other evidences it may be said that he remained at Kāth.
 126. Abi Naṣr Maṣṣūr has been mistaken for Amīr Nuḥ bin Maṣṣūr, Samanid ruler of Bukhara (997–99 A.D.) while contemporary chronicles do not corroborate this fact. See *Encyclopaedia of Islam*, p. 126.
 127. *The Chronology*, p. 338.
 128. The verses are as follows: A wise man of old has said: 'Man's greatness depends upon two small things (heart and tongue); I also put forward the contention like that wise man, that man's greatness depends upon two dirhams; he who lacks two dirhams

- his bride also does not pay attention to him; He is disgraced and degraded by his poverty and other people's cats also urinate upon him.' See *The Chronology*, p.338.
129. Lane Poole, *Mohammadan Dynasties*, p. 142. (Nandana is now located in Pakistan).
130. See *Encyclopaedia of Islam*, p. 123.
131. His *rasā'il* and *maktūbāt* (epistles) command respect. He was an excellent calligraphist. *Lubāb al-Lubāb*, Vol. I, p. 29.
132. Al-Bīrūnī, *Risālah al-ta'āl ba jalāh al-waham fi ma'ni manzūm uli al-Fadl* as quoted in *Irshād al-Uraih*, Vol. VI, p. 149.
133. *Irshād al-Uraih*, Vol. VI, p. 309.
134. See *infra*, Chapter V.
135. See 'Utbī, p. 77, Gardizi, p. 53, see also *Jannat al-Firdaws* and *Zinat Majālis* as quoted by Nazim, *The Life and Times of Sultān Mahmūd of Ghazna*, pp. 184–85.
136. Ya'qut, *Mu'jam al-Udaba*, Vol. II, pp. 102–103; Vol. XVIII, pp. 186–87.
137. See also Afnan, *op.cit.*, pp. 62–63.
138. See *Ency. Islam*, p. 1232.
139. Traditions attributed the concentration of all these scholars including al-Bīrūnī to al-Suhaīlī (*Chahār-Maqālah*, p. 85). However, it would be unjust to ignore Abu al-Hassan 'Alī, the master of al-Suhaīlī, whose munificence made this gathering possible.
140. *Chahar Maqālah*, p. 85.
141. *Mu'jam al-Udaba*, Vol. V, pp. 31–44.
142. Ahmad b. 'Umar al-Nizāmi, Al-'Arūdī Al-Samarqandi wrote this story in his *Chahār Maqālah* during the latter half of the twelfth century A.D. Later historians added more details. See Ahmed Allah's *Tārīkh-i-Nigāristān*, (1551 A.D.) pp. 135–37. See Browne, *A Literary History of Persia*, Vol. II, pp. 95–98.
143. Browne, *op.cit.*, Vol. II, p. 95. O'Leary *Arabic Thought in History*, p. 1.72, Afnan *Life and Works of Avicenna*, pp. 63–64. S. Hasan Barni, al-Biruni, pp. 56–58.
144. Some scholars have wrongly described Mahmūd as son-in-law of Abu al-'Abbās. See Raverty, *Tabaqāt-i-Nāsiri*, p. 120, n–5.
145. See Bayhaqi, pp. 838 and 840–4.

CHAPTER III

146. *Chahār-Maqālah*, p. 86; *Nigāristān*, p. 136. See Browne, *op. cit.*, Vol. II, p. 95.
147. *Nigāristān*, p. 136. Bayhaqi, *op. cit.*, pp. 838–40.

148. Jurjānī met Ibn Sīnā in Jurjān in 402 H. (1012–13 A.D.). *Kitāb al-Shifā's* preface to Logic vide Mahmūd Shāhābī (Teheran), *Introduction to the Risala Rawan Shamsi*, pp. 12–14. See also S. Hasan Barni, Ibn Sina and al-Bīrūnī, p. 4, extract from *Avicenna Commemorative Volume*, Iran Society, Calcutta, also see Afnan, *Life and Works of Avicenna*, pp. 62–65.
149. Bayhaqī, p. 241.
150. Sachau admits paucity of information and tries to form a picture through deductions (*India*, Eng. Tr., Vol. I, p. XVI).
151. See Sachau, *India*, Vol. I, p. XVI. See Hasan Barni, *Kitāb al-Tahdīd*, *Islamic Culture*, pp. 4 and 9.
152. Al-Fadlī, *Āthār al-Wuzrā*, p. 192.
153. In a letter written thirteen years before his death, al-Bīrūnī desired Divine Grace, protection from disturbances, a long life with full faculties and health for finishing the incomplete books such a *Qānūn al-Mas'ūdī*, etc.
154. *India*, Vol. I, p. 152.
155. See translation of al-Bīrūnī's introduction to *Qānūn al-Mas'ūdī* in *India*, Vol. I, p. XIV.
156. See Ya'qūt, *Mu'jam al-Udabā*, Vol. XVIII, p. 187.
157. *Ibid.*, p. 312.
158. See H. Barani, *Al-Bīrūnī*, p. 226.
159. *India*, introduction, pp. XI–XII; Vol. I, p. 24.
160. See *Mu'jam al-Udabā*, Vol. XVIII, p. 186 et seq.
161. See *Kitāb al-Tahdīd*, *Islamic Culture*, pp. 4 and 9. Barani, *Al-Biruni and his Magnum Opus*, *Introduction to Al-Qānūn al-Mas'ūdī*, Osmania Oriental Publication Bureau, Off. Print, Hyderabad, 1956, p. VII.
162. H. Barani, *Islamic Culture*, p. 4.
163. See Nazim, *op. cit.*, pp. 91, 93–5 and 106.
164. *India*, Vol. I, p. 317.
165. See Arnold Toynbee, *Between Oxus and Jumna*, p. 53.
166. *India*, Vol. I, p. 198.
167. See J.H. Kramer, *Al-Bīrūnī's determination of geographical longitude by measuring the distances*, *Com. Vol.*, p. 179.
168. H. Barani, *Muslim Researches in Geodesy*, *Com. Vol.*, p. 34. See also Sachau (*India*, Vol. II, p. 325), who favours Multan.
169. *India*, Vol. I, p. 317.
170. *India*, Vol. I, pp. 21, 116, 153, 205, 211, 240, 260, 300, 302, 308, 317, Vol. II, pp. 6, 8, 9, 54, 145, 148 and 184. See Barani, *Al-Biruni*, p. 89.

171. Al-Biruni, *India*, Vol. I, pp. 117–18, Gardizi, pp. 107 and 67–68, 'Uṭbī, p. 212, 'Unṣurī, p. 80. See also Nazim *op. cit.*, p. 160. The Ismā'īlīs tried to regain power in the reign of Mas'ūd (see Muktana Bahā-al-Dīn's letter as quoted by Elliot, *Historical Notes in Historians of Sind*, Cal. ed. p. 92. They succeeded in their efforts and Mu'iz al-Dīn had to fight them again.
172. *India*, Vol. I, p. 317.
173. *Ibid.*, p. 24.
174. Al-Biruni's measurements at Jurjaniyah, his birth place, were taken with the help of the *Shāhi* ring. This ring was probably named after the Khwārizm Shah (Sachau's translation; 'mitdem sichtigen Ring', is far beside the mark, see Kramer, Al-Biruni's Determination of Geographical Longitude, *Com. Vol.*, p. 189. The Yemeni ring could be a special variant of an observation instrument. It was not an octant but rather a decorative device in which each time eight minutes were singled out. (Kramer, *Ibid.*, pp. 179 and 185).
175. See the second chapter of the sixth treatise of *Qānūn al-Mas'ūdī*.
176. With the "transfer of the time moments" Al-Biruni seems to have made the astronomical tables especially for Ghaznah in order to give this town and the reigning Ghaznawids a scientific standing corresponding with their political importance (see Kramer, *Com. Vol.* p. 185).
177. Yaq'ūt, *Mu'jam al-Udabā*, Vol. VI, p. 310. This episode probably occurred before 1024 A.D. For in that year al-Biruni knew about these things from the Bulgars. He does not refer to the fact that this information was provided to him by the Bulgars. It may therefore be assumed that the episode of the Turk occurred before the arrival of the embassy.
178. Minorsky gives the year of the embassy as 1027 A.D. (On some of Biruni's Information, *Com. Vol.*, p. 234). However, as the embassy came in 417 H. (Gardizi, p. 87) 1026 A.D. is to be accepted. There were two embassies: one from the ruler of Qata (Khita, Chinese Kitan) and the other from the Ighur Khān, ruler of Quchu, with proposals to enter into matrimonial alliance with the Sultān. Such an embassy could be interviewed only by a person who enjoyed the Sultan's confidence and trust. See *Kitāb al-Jamāhir*, ed. Krenkow, p. 83 and Saydnah in Zaki Validi Togan, *Biruni's Picture of the World*, *Memoirs of the Arch. Survey of India*, No. 53, p. 118.
179. The reference is to *waranj*, *warank* (Slavonic Vareng/Vurang: Greek: Barangos) by which name the Norsemen were known in ancient Russia and the Byzantium. Other references in the *Tahdīd al-amākin* show that he learnt these exact details about their seafaring habits and geography from the Bulghar embassy of 1024 A.D.

- The ruler of Bulghar, after a dream, made offerings to the mosques of Sabzwār and Khusrawgird and also sent presents to Maḥmūd (see Bayḥāqī, p. 63).
180. Bertold, p. 289. Ḥajī Khalīfā, *Kashf al-Zunūn*, ed. Flügel, Vol. II, p. 327. Awfi, *Lubāb al-Lubāb*, p. 24. Guṣīdā, p. 395; Firīṣṭah, Vol. I, p. 67. *Tā'rikh Fakhr al-Dīn Mubārak Shāh*, p. 52, see also the lexicon, *Bahār al-'Ajām*, under the word *Fīlwār*. See also *Majma' al-Ansāb*, ff. 246 b–247 b. See Nazim, *op. cit.*, p. 158, n. 1.
 181. Sachau, *India*, Vol. I, pp. XIII–XIV. It is said that al-Bīrūnī's repeated correct forecasts angered the whimsical Sultan. He ordered the latter to be imprisoned. After sometime Maimandī noticing Maḥmūd in a good humour suggested that such a great astrologer like al-Bīrūnī should not be kept in prison. On his request Maḥmūd released him (*Chahār-Maqālah*, p. 65). Similar apocryphal romantic stories about Maḥmūd and his page Ayaz have been reported. See Nazim, *op. cit.*, pp. 153, 158.
 182. See Baranī, *Al-Bīrūnī and his Magnum Opus, al-Qānūn al-Mas'ūdī*, p. VII.
 183. See *Fihrist*.
 184. *India*, Vol. I, p. 23.
 185. The Hindu-Shahiya territories together with Kashmir were important centres of learning. The *Sihyahavrittī* a treatise on grammar by Ugrubhuti, the teacher of Anandapala was current in these regions. (*India*, Vol. I, p. 135). Thus al-Bīrūnī could have learned his Sanskrit from these non-Muslims.
 186. *India*, Vol. I, p. 208.
 187. *Ibid*, p. 208, Lahore was 56 miles away from the capital of Kashmir (*Ibid*, p. 317).
 188. The Sultan attacked Kashmir in 1015 and 1021 A.D. respectively but failed to reduce the fort of Lahkot (330 48'N Long. 74° 23' E). On both the occasions severe cold cut short the campaign. Gardizi, pp. 72, 73, 79, see also Nazim *op. cit.*, pp. 104–105.
 189. Jālam bin Shāyḥān destroyed the sun temple of Multan (*India*, Vol. I, p. 116).
 190. From Sind hailed Abu Ma'shar Najīb, one of the biographers of the Prophet and Abu 'Atā, a poet. See Suleman Nadwi, *Arab wa Hind Key Ta'alluqāt*, p. 303.
 191. He repeatedly quotes from Balabhdhara of Multan: *India*, Vol. I, p. 156. See also Vol. II, p. 305.
 192. These were the months when most of the expeditions of Maḥmūd were undertaken.
 193. He mentions Sialkot, Mandakkakor and Multan separately from other cities of the Punjab. See *India*, Vol. I, p. 317.
 194. *India*, Vol. I, p. 23.
 195. *India*, Vol. I, p. 318.
 196. Sachau, *India*, Vol. I, pp. XIV–XV. Baranī, *Al-Bīrūnī and his Magnum Opus*, p. XXXVIII.

197. Edward Thomas, *On the Coins of the Kings of Ghazni*, London 1848, p. 57; K.N. Dikshit, A Note on the Bilingual Coins of Sultān Maḥmūd of Ghaznah, *JRASB*, letters, Vol. II, 1936, No. 3, issued, 1938, Numismatic supplement, p. 29, see also Suniti Kumar Chatterji, *Al-Biruni and Sanskrit, Com. Vol.*, pp. 96–100.
198. See Suniti Kumar, *Com. Vol.*, p. 94.
199. Philip K. Hitti, *The History of the Arabs*, pp. 441–45.
200. See al-Ma'arri, *Risālat al-Ghufrān*, p. 153. See Nazim *op. cit.*, pp. 163–4, cf. Muḥammad Habib, *Sultān Maḥmūd of Ghazni*, 2nd ed., p. 29.
201. Gardizi, p. 80. See also Nazim, *op. cit.*, p. 114.
202. See Suniti Kumar Chatterji, *Al-Biruni and Sanskrit, Com. Vol.*, pp. 96–100.
203. It is interesting to note that among the Ismā'īlīs Ḥujjat Pir Ṣadr al-Dīn, Nūr Saṭgur, in his book *Dasavtār* described the Prophet and his cousin 'Alī as incarnations of gods (Mujtaba 'Alī, p. 99, n. 4, vide Arnold, *Preaching of Islam*, p. 277).
204. For details see Ch. IV.
205. *India*, Vol. I, p. 198.
206. *Chahār Maqālah*, pp. 64–66 and 86.
207. *Mu'jam al-Udaba*, Vol. XVIII, p. 187.
208. Bayḥaqī, p. 495.
209. See Nazim, *op. cit.*, pp. 169–70; Āthār al-Wuzra, p. 192.
210. See the Introduction of *Qānūn al-Mas'ūdī* as given by Barani, *Al-Biruni*, Urdu, pp. 229–30.
211. *Mu'jam al-Udaba*, Vol. XVIII, pp. 184–85.
212. *Rawḍat al-Ṣafā*, Vol. IV, pp. 30, *et seq.* *Firishtah*, Vol. I, p. 49, *et seq.*, and 184–185.
213. *Mu'jam al-Udaba*, Vol. XVIII, pp. 184–85.
214. *Mu'jam al-Udaba*, Vol. XVIII, p. 182.

CHAPTER IV

215. On this very basis Sarton has designated the period between 1000 to 1050 A.D. as the age of al-Biruni. (*An introduction to the History of Science*, Vol. I, p. 693).
216. Al-Kindī was the first Muslim scholar to classify the sciences according to the Aristotelean division of five major groups. The tradition persisted even after him. See Seyyed Hossein Nasr, *Science and Civilization in Islam*, pp. 60–64.
217. See Hossein Nasr, *op. cit.*, *Ibid.*
218. Sarton has mentioned Al-Khwarizmi's year of death as 850 A.D. (*An introduction*

- to the History of Science, Vol. I, p. 563), while Hossein Nasr, *Science and Civilization in Islam*, p. 45, mentions it as 249/863 A.D.
219. See the list of books enumerated in al-Biruni's letter. Ḥabash (d. between 864—74) was an astronomer under Ma'mūn and Mu'taṣim. See Sarton, *op. cit.*, p. 565.
 220. It needed finishing touches in 1035 A.D. *Fihrist*. Sarton, *op. cit.*, Vol. I, pp. 563—567.
 221. Sarton, *op. cit.*, Vol. I, p. 602.
 222. These books were referred to by al-Bīrūnī in his famous letter. They were: *Kitāb fi al-Samāwāt*, *Kitāb fi tanṣīf al-Ta'dīl wa ash'ah al-Sind Hind*, *Kitāb fi Tashīh Kitāb Ibrāhīm b. Shīn'an fi Tashīh*, *Kitāb fi brahīn a'mal Ḥabash ba jadul al-Taqwīm*, *Risālah fi Tashīh ma waqa'la bi Ja'far al-Khāzin min al-sahaw fi zīj al-Safā'ih*, *Risālah fi Mahārat dawā'ir al-Samāwāt fi al-astarlab*, *Risālah fi Jadul al-daqa'iq*, *Risālah fi brahīn 'ala 'amal Muḥammad bin al-Sabbah fi imtāhan al-Shams*, *Risālah fi brahīn 'ala 'amal Ḥabash fi muta'la samat fi zījāh*, *Risālah fi dawā'ir al-ti tahad al-Sā'at al-Zamāniyah*, *Risālah fi ma'rafah al-qassi al-falak la-tariq ghair tariq al-nisbatah al-mu'allafah*, and *Risālah fi hal shubha' aradta fi al-thalithah 'ushr min kitāb al-ūṣul*. In the same way also Abū Sahl Masīhī and Abu al-Ḥasan bin 'Alī al-Jalīlī wrote books in the name of al-Bīrūnī. See *Fihrist*.
 223. See Ibn Khallikan, *Wafayat al-A'yān wa Anbā' Abna' al-Zamān*, Eng. tr. Moin-ul-Haq, Vol. V, Pakistan Historical Society, pp. 197—203, also see Sarton *op. cit.*, Vol. I, p. 628. Hossein Nasr, *op. cit.*, pp. 293—296.
 224. See Sarton, *op. cit.*, Vol. I, p. 628, Ali Aḥmad Al-Shahhat, *Abu Rayḥān al-Bīrūnī*, pp. 60 *et seq.*
 225. Bayḥaqī (*Tatimmat*....p. 40) stated that Avicenna and his father used to read *Rasā'il Ikhwan al-Ṣafa*, which was probably correct. See Afnan, *op. cit.*, p. 58, He served as wazīr at Hamadan and also at Isfahan. Arberry, *Aspects of Islamic Civilization*, pp. 139 and 141.
 226. See the *Chronology*, text, p. 257.
 227. It was an essay on logic and later became a part of the *Najāt*. Ibn Sīnā, on receiving these queries wrote the answers in fifty sheets in one night-long sitting. Arberry, *op. cit.*, pp. 144—145.
 228. Barani, *al-Bīrūnī*, pp. 60—62. See also the journal *Ḥassan*, Vol. V. No. 10, Oct. 1892, pp. 48—52 as quoted by Barani. See also by the same author's extract from *Avicenna Commemorative Volume*, Ibn Sina and al-Biruni, Iran Society, Calcutta, pp. 10—12; Dekhoda, 'Ali Akbar, *Sharḥ-i-hali-nabighif-i-Shahir-i-Iran Abu Raiḥan Muḥammad ibn Aḥmad Khwārizmī-i-Bīrūnī* (Tehran 1495), 29 ff. vide S.H. Nāsr's

229. Al-Ghazālī also attacked Ibn Sīnā on this issue. See Ghazali, *Tahafat*.
230. See Hossein Nasr, *op. cit.*, pp. 134–35.
231. What al-Bīrūnī means is that if a square consists of indivisible parts, the number of parts on the side and in the diagonal must be equal, as in the figure shown below:



If the indivisible parts were to be connected, side and diagonal would be equal, which is impossible, and if the parts were to be connected on the sides, but remain separated on the diagonal there would have to be space between them. If these spaces were equal to the indivisible parts, the diagonal would be twice the side, a conclusion which is also impossible. Therefore, the space must be smaller or larger than the indivisible parts, thus indicating that the indivisible parts possess quantity, and can therefore be divided. See S. Hossein Nasr, *op. cit.*, pp. 135–36.

232. Ibn Sina stated that, if light was due to emission of some sort of particles by a luminous source, the speed of light must be finite. See Sarton, *op. cit.*, Vol. I, p. 710.
233. The *Chronology*, Arabic, introduction, pp. 35–36 and 257. The same arrogance is found in other men of achievement. Ibn Sīnā himself was scornful of Miskawayh. See Qitfi, p. 331, as quoted in Afnan, *Avicenna*, p. 53.
234. See Barani, *Al-Bīrūnī*, p. 62.
235. In *Qānūn al-Mas'ūdi* (pp. 508–509). Al-Bīrūnī, discusses the defects of Ibn Sīnā's method in finding the correct longitude of Jurjān. It is interesting to note that though Jurjānī credited Ibn Sīnā with a number of discoveries and innovations in mathematics and astronomy yet Ibn Sīnā in his own words possessed only a working knowledge of these subjects. In his first major work the compendium of knowledge, mathematics was not included. However, his *Kitāb al-Shifā'* dealt with mathematics and music also. But he is not recognised as a great mathematician or astronomer. His main interest seems to be limited to music. Therefore, al-Bīrūnī's distrust of his rival's knowledge in mathematics and astronomy, seems to have been justified. Arberry's *Aspects of Muslim Civilization*, p. 141.
236. See Arberry, *The Legacy of Persia*, p. 316.
237. See Sarton, *op. cit.*, p. 609. See Afnan, *op. cit.*, pp. 34–35.
238. See Bīrūnī's letter published with *Āthār al-Bāqiyah*. See also Barani, *Al-Bīrūnī*, pp. 214–215.

239. See al-Bīrūnī's letter.
240. See Sarton, Vol. I, p. 721. See also H. Nasr, *op. cit.*, pp. 49–50 and 128–32.
241. Ibn Khallikān, *Wafayat al-A'yan wa Anba' Abna al-Zamān*, ed. Eng. Tr. S. Moinul Haq, 1961, Karachi, Vol. II, pp. 434–37.
242. See also Sarton, Vol. I, pp. 716–17.
243. She could have been the daughter of Abu al-Ḥassan Awkhur bin Ustād Yazdān Khāsīs who was an expert on hay'iyat and was proficient with ancient Persian customs and traditions. See the *Chronology*, Arabic, p. 44. See also Barani, *Al-Bīrūnī*, pp. 132–35. *Encyl. of Islam*, Vol. I, p. 1236.
244. See Bīrūnī's list of books as enumerated in his letter (*Fihrist*).
245. *India*, Vo. I, pp. 5–7.
246. *Chahār Maqalah*, p. 86.
247. Following are the names of the works written by Abu Sahl in the name of al-Bīrūnī: *Kitāb Mubadī al-Hindsah*, *Kitāb Rasūm al-hārkat fi ashya'dhwaṭ al-wad*, *Kitāb fi sakun al-ard aw ḥarkathah*, and *Kitāb fi al-tawassuṭ bin Arastutalis wa al-Jalinus fi al-muḥarrik al-awwal* (a comparison between the ideas of Galen and Aristotle and an attempt to bring about compromise between them. It may be noted that Galen's influence was noticeable in formulating Rāzī's thinking. Al-Bīrūnī's anti-peripatetic thinking, may also be traced to the same origin). *Risalah fi dalālat al-lafz 'ali al-ma'ni* (on logic), *Risalah fi Ṣabah burud ayyam al'ajwā: al-Nujūm*, *Risalah fi adab ṣuḥbat al-Mulūk*, *Risalah fi qawanīn al-ṣana'ah* (laws of astronomy), *Risalah fi dastūr al-khaṭ* (instructions on script writing), *Risalah ghazalyat al-shamsiyah* (about black spots on the sun), and *Risalah al-zajsiyah* (or *Risalah Nargisyah*).

CHAPTER V

248. See al-Bīrūnī's introduction to *Qānūn-i-Mas'ūdī*, vide Barani, *Al-Bīrūnī*, p. 230.
249. See Barani, Introduction of *Kitāb al-Taḥdīd*, *Islamic Culture*, p. 4. They called the astronomers as *mulhids*, a term often used for Ismā'īlīs.
250. See Barani, *Kitāb al-Taḥdīd*, *Islamic Culture*, p. 5.
251. *Al-Qur'ān*, III, 191.
252. See *Kitāb al-Taḥdīd*, Barani, *Islamic Culture*, p. 5.
253. See *Qānūn al-Mas'ūdī*, pp. 21. & 43. See also Barani and his magnum opus, *Al-Qānūn al-Mas'ūdī*, *Qānūn al-Mas'ūdī*, 1956 Hyderabad. However, Ibn al-Haytham and Abū Sahl al-Kūhī believed in the above mentioned theory. Some of al-Bīrūnī's contemporaries believed in a universal force residing in matter and attracting the bodies. In all

these theories, al-Bīrūnī is very close to the concepts as expressed by modern physicists and scientists such as Einstein and Eddington.

254. See Barani, *Kitāb al-Taḥdīd*, *Islamic Culture*, p. 6.
255. See Barthold, *Mussulman Culture*, p. 92. Aristorchos of Samon (flourished in B.C. 280) was the first to put forward the heliocentric hypothesis. He was followed by Seleucus of Babylonia, Aryabhata of Patliputra and al-Sijzi (951–1024 A. D.) supported this theory. See Sarton, *op. cit.*, pp. 156, 309 and 665.
256. Abu Naṣr Maṣṣūr's book *Fi Kurriyatah al-Sama'* has been published at Hyderabad, India.
257. See his book *al-Istī'āb*. See also Barani, *Al-Bīrūnī*, p. 211; Moulvi Inayat Allah, *Ḥaḥāt-i-Abu Rayḥān al-Bīrūnī*, pp. 21–22. See *Qānūn al-Mas'ūdī*, pp. 50–51. The contemporaries of Copernicus for the above mentioned reasons did not believe in latter's theories. See George Forbes, *History of Astronomy*, published by Watts and Co., 1909–38. See also Bertrand Russell, *Religion and Science*, pp. 30–31.
258. See *Mu'jam al-Udaba*, Vol. XVIII, pp. 310–11.
259. The last part of Chapter IV to the end of the next *maqālah* (treatise) deals with the problems (*Qānūn* pp. 65–70). See the *Chronology*, Ch. I, III, V, VI. See also *India*, Vol. I, p. 319, *et. seq.* Also Vol. II, p. 129, Ch. XXVII, LXII.
260. *Qānūn*, pp. 59 and see *India*, Vol. II, pp. 6–7.
261. *Qānūn*, p. 145. However, when the Prophet (peace be on him) after performing 'Umrah in 7 A.H. in the month of *Dhu'al-Qadah*, returned to Medina, he stayed there during the month *Dhu'al-Hijjah* and the Meccans remained busy supervising the pilgrimage. See Ibn Ishāq Tr. Gaullame, 1967, Karachi, p. 538.
262. See also *Chronology*, pp. 329–30. The date of the Prophet's (peace be on him) birth is calculated on the basis of a *ḥadīth* which states that on *dū-Ṣhanbah* occurred his birth, call to Prophethood and *Hijrat* to Medina. According to al-Bīrūnī's calculations *dū-Ṣhanbah* fell on the 1st and the eighth *Rabi'al-Awwal*. *Qānūn*, p. 145.
263. See *Ṣhahhat*, *Abū al-Rayḥān al-Bīrūnī*, p. 12.
264. See *Qānūn*.
265. *Qānūn*, p. 637, also see Barani, introduction, pp. XIII–XIV.
266. See *Qānūn*, pp. 655–64.
267. *Ibid.*, p. 677, see also *Kitāb al-Taḥfīm*.
268. *Qānūn*, pp. 74, 857, 874.
269. See *Qānūn*, *Maqālah*, VIII, see also *Fihrist*, p. 31.
270. *Kitāb al-Taḥdīd*, pp. 99–101; *Qānūn*, *Maqalah* IV.
271. See *Kitāb al-Taḥdīd*, pp. 99–101.

272. See Barani, *Islamic Culture, Kitāb al-Taḥdīd*, pp. 8–9.
273. *Qānūn, Maqālah*, VIII, XIII, see also *Fihrist*.
274. *Qānūn al-Mas'ūdī*, p. 785.
275. *Ibid.*, p. 776.
276. *Ibid.*, p. 746.
277. *Ibid.*, pp. 730, 745–46.
278. *Ibid.*, p. 776.
279. *Ibid.*, p. 865.
280. *India*, Vol. II, pp. 103 and 105.
281. See *Qānūn, Maqālah*, VIII.
282. *Qānūn*, p. 992.
283. *Ibid.*, p. 992. Although the quasars are even more distant, nevertheless al-Bīrūnī's approach appears to be singularly original.
284. *Ibid.*, p. 1012.
285. See *Kitāb al-Taḥīm*, Persian ed. p. 135.
286. See *Qānūn*, p. 1310.
287. *Ibid.*, pp. 1031, 1161 and 1166.
288. See Hossein Naṣr, *op. cit.*, p. 174.
289. *Qānūn*, pp. 1163–1166. For English translation see Hossein Naṣr, *op. cit.*, pp. 179–81. Al-Bīrūnī, *Qānūn al-Mas'ūdī*, Hyderabad, India, 1956, III, pp. 1663–66. His study of the use of the planets by the Indians. See *India*, Vol. I, pp. 214 *et seq.*
290. See *Qānūn*, p. 1126. For Hindu practices see *India*, Vol. II, pp. 245–46.
291. *Chahār Maqālah*, pp. 64–66.
292. See *Kitāb al-Taḥīm*. Persian ed., p. 316.
293. See *Kitāb al-Taḥdīd*, p. 324.
294. See *Qānūn*, p. 1354.
295. See *al-Fihrist*, p. 41. Some of them determined his age to be 16 years, some 40 and others 60, while he was in fact more than 80 years old.
296. See *India*, Vol. I, p. XXXVII.
297. See *Qānūn*, p. 1469.
298. See Barani, Introduction to *Qānūn al-Mas'ūdī*, p. LXIX. "As in the preceding part of our this book, we have given something of every thing, we shall also give as much of their astrological doctrine as will enable our reader to discuss questions of similar nature with them. If we were to give an exhaustive representation of the subject, this task would detain us very long...." *India*, Vol. II, p. 211.

CHAPTER VI

299. Hossein Nasr, *op. cit.*, p. 167.
300. See the Enumeration of the Sciences' (*Itḥṣā al-'ulūm*) of al-Farabi who describes the science of mathematics having seven main parts: arithmetic, geometry, optics, astrology, music, weights and mechanics (see M. Bouyges *Sur le de Scientiis d'al-Farabi*, *Melanges de l'Universite Saint Joseph*, Saint Joseph, IX (1923-4), pp. 41-96 as quoted by Levy, *The Social Structure of Islam*. Al-Safa the *quadrivium* of arithmetic, geometry, astronomy and music came to be accepted as the main parts of mathematics (Levy, *op. cit.*, p. 473). See also Hossein Nasr, *op. cit.*, p. 146. See also *India*, Vol. I, Chapters XIII, XIV, XV etc.
301. See *Fihrist*, vide the *Chronology*. Probably it is the same book which has been designated as *Maqālid al-'ilm Ḥadath fi basit al-Kurah*. See Ṭusi edited by Cartheodry as quoted in M. A. Kazim's *al-Birūnī and Trigonometry*, *Com. Vol.*, p. 162:
302. See *Fihrist*.
303. See M. A. Kazim, *al-Birūnī and Trigonometry*, *Com. Vol.*, p. 163.
304. The formula is $S8 = \sqrt{r - r(r/2 - y)}$ or $S8 = \sqrt{2 - 12}$
305. See M.A. Kazim, *op. cit.*, p. 164.
306. Aziz, *op. cit.*, p. 164.
307. *Qānūn, Maqālah III*, Ch. IV, see also Aziz, *op. cit.*, p. 164.
308. See Kazim, *op. cit.*, p. 165.
309. Al-Birūnī's second formula corresponds to a similar formula of Newton.
310. See *Qānūn, Maqālah III*, Introduction, Ch. VI.
311. See M.A. Kazim, *op. cit.*, p. 168.
312. See the list of 25 chapters of *Brahma Siddhanta* given by al-Birūnī in *India*, Vol. I, pp. 154-55. Its 13th chapter deals with arithmetic, plane measures and cognate subjects.
313. See Shahhat, *op. cit.*, (manuscript) by H.K. Ghazanfar, pp. 89, 94.
314. See *Qānūn al-Mas'ūdī*, p. 991, where, while discussing the stars, al-Biruni leaves the question of their colour for the physicists.
315. See *Fihrist*.
316. See Chapter XIII of *Maqālah VIII*, of *Qānūn*.
317. See Shahhat, *op. cit.*, pp. 201-3
318. *The Chronology*, Arabic, pp. 261-75.
319. See A. Mieli as quoted in Hossein Nasr, *op. cit.*, p. 140; also see Sarton, *op. cit.*, Vol. I, p. 708.

320. *The Chronology*, Arabic, pp. 261–75.
321. *Kitāb al-Taḥqīm*, MS. Alijar, pp. 224–31.
322. See *Fihrist*.
323. See al-Bīrūnī's *Istī'āb*, tr. by S. H. Barani, in al-Bīrūnī's Scientific Achievements, Indo-Iranica, Vol. V, No. 4 (1952).
342. See *Fihrist*.
325. *Ibid*.
326. *India*, Vol. I, pp. 160–66.
327. *Fihrist*.
328. *India*, Vol. I, pp. 187–190.
329. *India*, Vol. I, p. 158.
330. *Charaka* was a title meaning the intelligent one. His original name was Agrivēsa. *Ibid.*, p. 159.
331. See *Fihrist*.
332. See the extracts from the *Saydanah* Eng. tr. F. Karekow, Biruni and the M.S. Sultān Fāṭih, *Com. Vol.*, pp. 195–96.
333. Earlier animosity towards foreigners made travelling a hazardous undertaking (see al-Bīrūnī, *al-Taḥdīd*). See also Hossein Nasr, *op. cit.*, p. 98, Nafis Ahmed, *Muslim Contribution to Geography*, Lahore, 1947, p. 35.
334. See Bashārī al-Maqḍisi, *Aḥsān al-Taḳāsim*, as quoted by Shāhhat, *op. cit.*, pp. 156–57.
335. See Alessandro Bausani, L'India Vista Da Due Grandi Personalità 'Mussuhnare; Babar E-Bīrūnī, *Com. Volume*, pp. 53–71.
336. *India*, Preface, Vol. I, p. 7.
337. *Kitāb al-Taḥdīd*, Tr. entitled as Bīrūnī and the MS. Sultān Fāṭih No. 3386, *Com. Vol.* p. 197.
338. *Ibid.*, p. 198.
339. *The Chronology*, pp. 13–14.
340. *The Chronology*, pp. 13–14.
341. See M.S. Sultan Fāṭih, *Com. Vol.*, p. 199, and the *Chronology*, pp. 13–14. He had held these beliefs from the very beginning.
342. See M.S. Sultan Fāṭih, *Com. Vol.*, p. 199.
343. See *al-Taḥdīd* as quoted by Barani, *Islamic Culture*, p. 6.
344. See M.S. Sultan Fāṭih, *Com. Vol.*, p. 199.
345. *Al-Taḥdīd*, p. 144, as quoted in reprint of Barani, Al-Bīrūnī and Ibn Sīnā, *Ibn Sīnā Commemorative Volume*, p. 6. See also Barani's introduction to *Qānūn al-Mas'ūdī*, p. XXX.

346. *India*, Vol. I, p. 197.
347. *India*, Vol. I, p. 196.
348. Columbus thought the circumference of earth as quite short and for this reason embarked upon his expedition with limited supplies.
349. *India*, Vol. I, p. 197.
350. *Ibid.*, p. 208.
351. *Ibid.*, pp. 197–98, 211 and 258.
352. Minorsky, Some of Bīrūnī's Informants, *Com. Vol.*, p. 235, n. 7.
353. *India*, Vol. I, p. 147.
354. *Ibid.* See also introduction of *Qānūn*, p. XXXI.
355. *India*, Vol. I, p. 147.
356. See *Shahhat*, *op. cit.*, p. 169.
357. See *Qānūn*, Introduction, p. XXXIII.
358. *India*, Vol. I, p. 258. However, the confusion was due to the information provided by the Vayu Purana which described other mountain ranges as the seven knots of Meru (*ibid.*, pp. 2, 47 and 257).
359. *India*, Vol. I, pp. 198, 199 and 259.
360. *India*, Vol. I, p. 207. The earlier travellers regarded the source of the Indus and the Jehun (Oxus) as one. See Ibn Hawqal, Elliot, Calcutta ed., p. 51. Al-Mas'ūdī, Elliot, Calcutta ed., pp. 27 and 29.
361. *India*, Vol. I, pp. 259–60.
362. Similar conditions persisted upto recent times. See Raverty, *Mihran*.
363. *India*, Vol. I, p. 208. Al-Bīrūnī's remarks about the course of the Indus in Sind were in a way hearsay evidence. However, it showed that the Indus which had been reported earlier in the previous century (Al-Mas'ūdī, Elliot, Cal. ed., pp. 27 and 29. Al-Iṣṭakh̲rī, Elliot, Cal. ed., pp. 34–35, Ibn Hawqal, Elliot, Cal. ed., p. 44) as surrounding Maṇṣūrah had two branches later became divided into a number of branches indicating an incipient change of its course. Probably in the later half of the 11th century or in the beginning of the 12th century the change took place and the river deserted Maṇṣūrah. References to that city ceased in the 12th century. For a detailed discussion of the aggrandizing characteristics of the Indus, see Ansar Zahid, *Sind under the Mughuls* (thesis), Ch. I.
364. The Turks had already settled in Afghanistan and these parts of Kashmir before their conversion to Islam. *India*, Vol. I, p. 207.
365. *India*, Vol. I, pp. 206–7.
366. *Ibid.*, pp. 211–12.

367. *Ibid.*, p. 201.
368. *India*, Vol. I, pp. 199 *et seq.*
369. *Ibid.*, pp. 210–11.
370. *India*, Vol. I, pp. 193–94.
371. *Ibid.*, pp. 203–5. The word sufalah he, however, employs for Sangla Hill, alternatively known as Sakalah or Saqalah in Al-Bīrūnī's time. See the *Kitāb al-Saydanah* (under faghīrah).
372. See *Fihrist*.
373. *India*, p. 24, see also *supra* Ch. V.
374. See *Fihrist*.
375. Dicaerchos (320 B.C.), Eratosthenes (295 B.C.) and Hipparchus (160 B.C.) were among those who measured the circumference. Eratosthenes found it to be 250,000 stadia, Posedonium (57 B.C.) 240,000 stadia, and Ptolemy (151 A.D.) 100,000 stadia. (Nallino, *Lectures* as quoted by Barani, *Com. Vol.*, p. 4). Among the Indians Aryabhata gave 3,364 Yojnas, Brahmagupta 5,000 Yojnas and Bhaskar Acharya, 4,967 Yojnas. (*India*, Vol. I, pp. 312–13). See also Premchanda's *Hindu Astronomy*, 1896, pp. 120, 193, 198 as quoted by Barani, *Com. Vol.*, pp. 5 and 16. Also see *al-Taḥḥīm*, pp. 156–64; *Qānūn, Maqālah*, V, Ch. VII.
376. See also Mas'ūdī, *Murūj al-Dhahab*, Vol. I, p. 75, *Al-Ṭabārī, Firdaws al-Hikmat*, Berlin, 1928, p. 547; Ibn Yunus, *Kitāb al-Zīj al-Kabīr* or. 143, No. 1057 Leyden, as quoted by Nallino, *Lectures*, p. 218.
377. *Al-Taḥḥid, Picture of the World*, pp. 65–66. Such efforts also needed command over a vast tract of land and a proper control over the parties dispersed in it.
378. See *Qānūn, Maqālah* VI, Chapter II, Eng. Tr. J.H. Kramer, *Com. Vol.* p. 184.
379. *Al-Kitan fi al-Aṣṭurlāb* vide Nallino, *Lectures*, pp. 289–92. *Kitāb al-Taḥḥid, Picture of the World*, by Validi, p. 245. Eng. Tr. Barani, *Com. Vol.*, p. 35. It may be noted that he did not refer to his stay at Nandana as a detention.
380. See also Nallino, *Ilm al-Falak, Tārīkhah 'ind al-Arab*, pp. 291–92.
381. These figures have been taken from Barani, *Al-Bīrūnī*, p. 201 and *Muslim Researches in Geodesy, Com. Vol.*, pp. 40, 41 and 50–52.
382. *Al-Taḥḥid*, Gr. Tr., Ahmet Zeki Validi, Folio 8 (a), vide J.H. Kramer, *Al-Bīrūnī's determination of geographical longitude by measuring the distances, Com. Vol.*, p. 190.
383. The Greeks started with *sus al-aqsa*, the Indians from Ceylon. Al-Bīrūnī himself started his measurements from the Atlantic coast, see also Barani, introduction to *Qānūn al-Mas'ūdī*, p. XXXX. In fact Kramer suggests this very hypothesis, see Kramer

op. cit., p. 185.

384. See *Qānūn, Maqālah* VI, Ch. II, Eng. Tr. *Kramery Com. Vol.*, p. 179.
385. See *Kitāb al-Taḥdīd*, Barani, *Islamic Culture*, p. 4.
386. See *Firhist*.
387. See *Qānūn, Maqālah V*, Chapters I–V, IX, X.
388. See *Qānūn, Maqālah*, II, Ch. II, Eng. Tr. *Com. Vol.* pp. 179–84.
389. See Barani, introduction to *Qānūn*, p. XXXIV.
390. *Ibid.*, pp. XXXIV–XIX.
391. See *Firhist*.
392. *Ibid.*, Unfortunately this work is lost.

CHAPTER VII

393. See *Fārābī Ihṣā al-'Ulum* as quoted by Levy, *op. cit.*, p. 469, also see Ibn *Khaldūn, Muqaddimah*, Eng. tr. Rosenthal, New York, 1950.
394. Ibn *Khaldūn, Muqaddimah*, Eng. tr. Rosenthal, abridgement by N.J. Dawood, London, 1967, p. 11.
395. Ṭabari was the first scholar to write a universal history, *Kitāb akhbār al-rusūl wa al-mulūk*, a remarkably accurate and elaborate work from the creation to 915 A.D., of Sarton, *op. cit.*, Vol. I, p. 642. The main work of Mas'ūdī was *Murūj al-Dhahab wa ma'dan al-Jawahir*, a historic-geographical encyclopaedia remarkable for the catholicity of the author, his full use of the sources of information available and his true scientific spirit.
396. *India*, Vol. I, p. 200.
397. See the *Chronology*, preface by the author and see also *India*, Vol. I, preface.
398. See the *Chronology*, preface.
399. *Al-Qur'ān*, IV, 134.
400. *The Bible*, St. Matthew X, 18, 19, 28; St. Luke, XII.
401. See *Kitāb al-Jawāhir wa al-Jamāhir* as quoted by Barani in his introduction to *Qānūn al-Mas'ūdī*, p. VII.
402. See the *Chronology*, preface.
403. Objections by some persons on the book *al-Masālik wa al-Mamālik* (the Routes and Kingdoms) led him to write *Kitāb al-Taḥdīd*. He also referred to other authors and books, see *al-Taḥdīd*, Eng. Tr. *Com. Vol.*, pp. 198–200.
404. *India*, Vol. I, p. 96.
405. He quoted details about an old earthquake at Antioch from Syrian histories. See

al-Taḥdīd, *Com. Vol.*, p. 201.

406. See the *Chronology*, pp. 74, 330 and 341. See also *India*, Vol. I, pp. 172, 174.
407. See *India*, Vol. I, p. 54; the *Chronology*, p. 331.
408. See *al-Taḥdīd*, *Com. Vol.*, p. 199.
409. He checked the evidence of some persons hailing from Qannawj and found that their replies to the questions put by him varied, *India*, Vol. I, p. 200, Vol. II, p. 29. See also *al-Taḥdīd*, *Com. Vol.*, p. 198.
410. *India*, Vol. I, pp. 3–5. He and his colleagues sadly noted the conscious and unconscious distortion in the description of opposite sects or pagans.
411. The *Chronology*, preface. Al-Bīrūnī's warning may be better appreciated in the light of the works of early Orientalists who were encumbered by the concepts of the 'white man's burden' and a condescending attitude towards the subject people including the savages of Africa and the ancient civilizations.
412. See *India*, Vol. I, p. 20.
413. Correction did not mean change in the context but rather a form of editing, i.e., identifying and correcting words of dubious spelling or meaning trying to understand its implication by tracing its root etc.
414. He had written books on all these topics (*Chronology*, pp. 78–84). One such book was *Kitāb al-'ajā'ib al-Tabī'ah wa al-gharā'ib al-ṣana'iyah*. In another treatise he discussed the researches of Abu Ḥafs 'Umar G. al-Furkhan on the same topics, see *Fihrist*.
415. See *India*, Vol. I, p. 26.
416. Here Sachau has expressed the meaning of "the truth" further in parenthesis as the true belief or monotheism. It may be further extended to mean the Islamic beliefs (see *India*, Vol. I, p. 24).
417. The *Chronology*, p. 72.
418. *India*, Vol. I, pp. 203–205.
419. *India*, Vol. I, p. 197.
420. See *al-Taḥdīd*.
421. *India*, Vol. I, pp. 400–401.
422. See Barani, *Kitāb al-Taḥdīd*, *Islamic Culture*, pp. 4–5
423. *Qānūn*, p. 145.
424. The *Chronology*, p. 78.
425. *India*, Vol. I, pp. 378–79.
426. Al-Bīrūnī mentioned seven castes in Iran which closely resemble the seven castes noted by Megasthenes in India. See *India*, Vol. I, pp. 99–100, cf. *Cambridge History*

427. *India*, Vol. I, p. 22.
428. *Ibid.*, Vol. II, p. 157.
429. *India*, Vol. I, p. 157.
430. *India*, Vol. I, pp. 76, 87 and 88.
431. *The Chronology*, Chapters III, V and VI. *India*, Vol. II, pp. 4–10.
432. *Ibid.*, Vol. I, pp. 21 and 54.
433. *India*, Vol. II, pp. 10 and 11. It is said that Kanishka built a Chaitya hall at Peshawar. The name was probably pronounced in Middle Indian dialect as Kamnikhu for Sanskrit Kanishka (see Sachau, *India*, Vol. II, notes, p. 361). The Turki Shāhiya seemed to have claimed a Kushan origin (see Sachau, *India*, Vol. II, p. 361, under Lagakiman. Cunningham (*Coins of Medieval India*, p. 55) prefers Kitorman. The ending Toraman may also suggest a link with the Huns rulers, Toramana and Mihirakula. The Turki Shāhiya could be a Hun dynasty and in order to avoid any Indian reaction against a remaining Hun house, could have assumed a Kushan genealogy. This would explain the time-gap between the Imperial Kushans and the end of the Turki Shāhiya in the last quarter of 9th century.
434. See *India*, Vol. II, p. 13, cf. Firishta, p. 19. Kalhana, II, pp. 105 and 336–39, also Kazim, *op. cit.*, pp. 194–96. It is rather interesting to note that in Sind also Chach, a Brahman, had usurped power some time back. A similar pattern was reported about Kashmir. These incidents could be the manifestation of the Brahmanical and indigenous revival against the foreigner and Buddhism.
435. *Ibid.*, p. 202.
436. Al-Bīrūnī's reference showing it southward of Bazna militates against its identification with Chittore. Chach *Namah* had a similar reference to Jitūr, (see Chach *Namah*, 1939, Delhi, pp. 26, 27.
437. *India*, Vol. I, p. 202.
438. *Ibid.*, p. 203.
439. *Ibid.*, pp. 208–9.
440. *Ibid.*, p. 116. However, later Ismā'īlīs were more syncretic, e.g., the book *Das awtār* by Sadr al-Dīn adopted the theory of Avtara or incarnation.
441. *Ibid.*, Vol. II, p. 145.
442. *Ibid.*, pp. 9 and 145.
443. *Ibid.*, Vol. I, p. 22.
444. *India*, Vol. I, p. 206. Al-Bīrūnī observed: 'In the former times they used to allow one or two foreigners to enter their country, particularly Jews, but at present they do

not allow any Hindu whom they do not know personally to enter, much less other people.'

445. *India*, Vol. II, p. 6.
446. *Ibid.*, The reference appears to Chandra Gupta II, Vikramaditya who destroyed Scythian (Saka) power. The story probably referred to the site of his final victory over the Sakas. It also points to the resurgence of indigenous culture over the Hellenistic.
447. *India*, Vol. II, p. 7. This reference to the Guptas militates against the traditions associated with Vikramaditya.
448. *India*, Vol. I, p. 100. See also the last sermon of the Prophet given during his farewell pilgrimage. Ibn Sa'ad's *Tabaqat*, Eng. tr., Pakistan Historical Society, Vol. II, p. 213.
449. *India*, Vol. II, pp. 100-3. This reference may relate to the *Purush Sukta* Hymn of *Rigveda*. See *Cambridge History of India*, Vol. I, pp. 86, 92 and 93; see also chapters LXIII and LXIV.
450. *Ibid.*, Vol. I, p. 103, Vol. II, p. 136.
451. *Ibid.*, Vol. I, p. 102.
452. *Ibid.*, Vol. II, p. 137.
453. *India*, Vol. II, pp. 137-38.
454. *Ibid.*, pp. 151-53.
455. *Ibid.*, pp. 154-155.
456. *India*, Vol. II, p. 156.
457. *Ibid.*, p. 157.
458. *Ibid.*, p. 162.
459. *Ibid.*, pp. 164-65.
460. *India*, Vol. I, p. 179.
461. *Ibid.*, pp. 179-86.
461. It appears that later the four sets were combined into two. The extra king became *Wazir* (queen) while other pieces remaining as they were.
463. *India*, Vol. I, p. 170.
464. *Ibid.*, p. 171.
465. *Ibid.*, p. 172.
466. *Ibid.*, pp. 21-22.
467. *India*, Vol. I, p. 173.
468. *Al-Mas'ūdi, Murūj al-Dhahab*, Elliot Cal. ed., p. 31. The languages of *Mausūrah*, Multan and those parts are Arabic and Sindian. In Makran they used Persian and

- Makranic. See Ibn Hawqal, *Kitāb al-Masālik wa al-Mamālik*, Elliot, Cal. ed. p. 50.
469. *India*, Vol. I, p. 173.
470. See Sachau, *India*, Vol. I, pp. XXXVI.
471. *Ibid.*, pp. 23–24 and 206.
472. *Ibid.*, pp. 125–126. The tradition of Vasukra and the earlier tradition of re-writing of the *Vedas* probably point to the fact that the earlier *Vedas* were forgotten and were later revived with the rise of Sanskrit. Vasukra could have been motivated by the decay of learning partly due to Muslim penetration of the sub-continent.
473. *India*, Vol. I, p. 130, cf. Gonda, Remark on al-Bīrūnī's quotations from Sanskrit, *Com. Vol.*, pp. 110–118.
474. *India*, Vol. I, pp. 131–32.
475. *Ibid.* He was acquainted with *Bhagvad Gita* also. He attributed Vayasa the son of Parasara with the re-discovery of alphabets (*ibid.*, p. 171). This might refer to the extinction of Pali and the re-emergence of Sanskrit. It seems that *Mahabharat* played a leading role in popularising Sanskrit.
476. *Ibid.*, p. 380, see also C. Bulcke, Al-Bīrūnī and the Rama-Katha, *Com. Vol.*, p. 78.
477. *India*, Vol. I, pp. 209–210; *Chronology*, p. 46.
478. *India*, p. 135 and 138.
479. *Ibid.*, pp. 155–159.
480. *India*, Vol. I, preface, pp. 7–8.
481. *Ibid.*, p. 7.
482. *Chronology*, pp. 67–68; *India*, Vol. I, pp. 263–64. See *Miqālāh Ru'yat Hiala* by Abī Naṣr, p. 11 as quoted by Barani in Ibn Sīnā and al-Bīrūnī, Ibn Sīnā *Com. Vol.* p. 7, n. 30.
483. One who loves 'Ali above the other companions.
484. *India*, Vol. I, p. 111. Though modern scholars regard this remark about the Jews as curious (Jaffrey, al-Bīrūnī's Contribution to Religion, *Com. Vol.*, p. 152) and probably a slip of pen. However, al-Bīrūnī could have been referring to what he saw or come to know.
485. See Jaffrey, *op. cit.*, p. 157.
486. *India*, Vol. I, pp. 103–5 and 123.
487. *Chronology*, pp. 332–33.
488. *Ibid.*, pp. 13–14 and 112.
489. *Ibid.*, pp. 14, 112 and 206.
490. Aristotle called them human beings and described them as beings of air and fire. *Chronology*, p. 237. See Jaffrey, *Com. Vol.*, p. 139.

491. *Chronology*, p. 249.
492. *India*, Vol. II, pp. 167–69.
493. *Ibid.*, p. 169.
494. *Ibid.*, pp. 168–69.
495. *Chronology*, pp. 62, 201, 211 and 214; *India*, Vol. I, p. 264.
496. *Chronology*, pp. 15, 16, 57, 58, 212 and 284.
497. *Ibid.*, pp. 21, 277 and 288.
498. *Chronology*, pp. 288 and 295; *India*, Vol. I, pp. 37–38; Vol. II, p. 161.
499. *Ibid.*, p. 55.
500. *India*, Vol. I, pp. 40 and 121, see also Sachau, preface to *India*, p. XLII.
501. *India*, Vol. I, p. 21. *Chronology*, pp. 318, 204 and 219–250.
502. He accused Ibn Muqaffa of wilfully introducing a new chapter in the translation of *Kalila wa Dimna* to justify dualism (*India*).
503. He placed Mānī in the Christian succession, the *Chronology*, pp. 207–209.
504. *India*, Vol. I, p. 27. See Heras, The Advaita doctrine in al-Bīrūnī, *Com. Vol.*, p. 119.
505. *India*, Vol. I, p. 18.
506. *Indja*, Vol. I, pp. 29–31. See also *Brhadaranyaka Upanishad*, IV, 4–19–21 as quoted by Heras, *op. cit.*, *Com. Vol.*, p. 119.
507. *India*, Vol. I, p. 32.
508. *Ibid.*, pp. 40, 48 and 51. This concept resembles Vedantic philosophy although al-Bīrūnī never referred to such philosophy. See Heras, The Advaita doctrine in al-Bīrūnī, *Com. Vol.*, p. 118.
509. *Ibid.*, pp. 59–61. Al-Bīrūnī mentioned 88,000 hells but gave the names of 16 only. See Gonda, *Com. Vol.*, pp. 111–113.
510. *India*, Vol. II, p. 163.
511. *India*, Vol. I, p. 50.
512. *Ibid.*, p. 33.
513. *Ibid.*, pp. 33–34. See Nicholson, *The Mystics of Islam*, London, 1966, pp. 3–4.
514. *India*, Vol. I, p. 33.
515. *India*, Vol. I, pp. 34 and 57. Arberry, *The Legacy of Persia*, Oxford, 1966, p. 159.
516. *India*, Vol. I, pp. 62–63.
517. *Ibid.*, pp. 55 and 64. The Muslims believing in God as the Judge of the Day of Judgement could not accept the Hindu versions. Therefore they accepted metempsychosis as a form of internal evaluation and change.
518. *Ibid.*, pp. 40, 69, 73 and 83. Similar miraculous powers were described by Patanjali for the one who had attained the stage of liberation. See also the nature of

purusha.

519. *India*, Vol. I, p. 87.
520. *Ibid.*, on difference in *Waladat al-Wujud* and pantheism, a word not found in Muslim literature, see Moinul Haq, Origin and Growth of Sufism, *Journal of the Pakistan Historical Society*, April 1973, p. 100.
521. *India*, Vol. I, p. 88, cf. Nicholson, *The Mystics of Islam*, London, 1966, p. 19. See also Moinul Haq, The Origin and Growth of Sufism, *Journal of the Pakistan Historical Society*, Vol. XXI, part II, April, 1973, p. 89. Arberry, *The Legacy of Persia*, Oxford, 1953, p. 159.

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